

MIL-T-38170F (USAF)
30 September 1981

SUPERSEDING
MIL-T-38170E
30 March 1973

MILITARY SPECIFICATION

TANK, MOBILE STORAGE, LIQUID OXYGEN TMU-27/M

1. SCOPE

1.1 This specification covers a trailer-mounted, 50-gallon mobile storage tank for air and ground transport, storage, and servicing of liquid oxygen, designated TMU-27/M.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

UU-T-81	Tags, Shipping and Stock
PPP-T-60	Tape, Pressure Sensitive Adhesive, Waterproof For Packaging

Military

MIL-C-104	Crates, Wood, Lumber and Plywood Sheathed, Nailed and Bolted
MIL-P-116	Preservation, Methods of
MIL-V-173	Varnish, Moisture and Fungus Resistant
MIL-R-3065	Rubber, Fabricated Parts
MIL-I-6866	Inspection, Penetrant Method Of
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-M-8090	Mobility, Towed Aerospace Ground Equipment, General Requirements For
MIL-A-8421	Air Transportability Requirements, General Specification For
MIL-R-13689	Reflectorized Sheeting, Adhesive (Retro-Reflective)
MIL-V-25961	Valve, Fill-Buildup-Vent, Liquid Oxygen Converter, CRU-50/A
MIL-P-27456	Purging Unit , Air, Liquid Oxygen Storage Tanks GSU-62/M
MIL-T-27730	Tape, Antiseize, Tetrafluoroethylene, With Dispenser
MIL-V-38201	Valve, Filler, Liquid Oxygen, Female, CRU-59/E
MIL-C-81302	Trichlorotrifluoroethane
MIL-H-83772	Hose Assembly, Metal, Cryogenic Liquid, Aircraft Servicing

FSC 3655

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STANDARDS

Military

DOD-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking For Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-143	Specifications and Standards, Order Of Precedence for the Selection Of
MIL-STD-470	Maintainability Program Requirements
MIL-STD-471	Maintainability Demonstration
MIL-STD-810	Environmental Test Methods for Aerospace and Ground Equipment
MIL-STD-831	Test Reports, Preparation Of
MIL-STD-838	Lubrication of Military Equipment
MIL-STD-889	Metals, Dissimilar
MIL-STD-1186	Cushioning, Anchoring, Bracing, Blocking, and Waterproofing, With Appropriate Test Methods
MIL-STD-1359	Cleaning, Methods and Procedures For Breathing Oxygen Equipment
MIL-STD-1595	Tests, Aerospace Welding Operators, Qualification

Air Force - Navy Aeronautical

AN929	Cap Assembly Pressure Seal, Flared Tube Fitting
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DRAWINGS

Ordnance Corps

8987830	Assembly, LOX Coupling, Male Half, All Sizes
8987832	Gasket, LOX and LN2, All Sizes
8987855	Seat, LOX Coupling, 1 inch
8987869	LOX Cap, 1 inch

Air Force

48B7796	Ring Assembly - Tie Down, 10,000 Pounds
68A39469	Plug
68A39470	Body
68A39471	Vacuum Pump - Out and Relief Assembly
68A39472	Cap
68A39473	Vacuum Pump - Out Assembly
68B39474	Filter Assembly, LOX
7545352	Requirements for Finishes, Protective, and Codes for San Antonio ALC Ground and Ground Support Equipment

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publication. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society of Mechanical Engineers

ASME Boiler and Pressure Vessel Code

Section VIII Unfired Pressure Vessels

(Application for copies should be addressed to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, New York 10017.)

3. REQUIREMENTS

3.1 Preproduction. This specification makes provisions for preproduction testing.

3.2 Components. The tank shall consist of the following major components:

<u>Description</u>	<u>See Requirement</u>
Interchangeable Liquid Storage Tank	3.8.1
Control Housing Assembly	3.8.2
Tank Mounting Chassis	3.8.3

3.2.1 Component schematic. Figure 1 is a component schematic of the tank lines, valves, relief devices, and instruments. The piping is shown on both ends for illustration purposes only. The actual tank design shall have all components with exception of the outer shell relief device located on one end of the tank.

3.3 Selection of specifications and standards. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143.

3.4 Materials

3.4.1 Fungusproof materials. Materials that are nutrients for fungi shall not be used where it is practical to avoid them. Where used and not hermetically sealed, they shall be treated with varnish conforming to MIL-V-173. For materials used in a hermetically sealed enclosure, fungicidal treatment will not be necessary.

3.4.2 Metals. Wherever practicable, lightweight metals shall be used in the construction of the tank. Metals shall be of the corrosion-resistant type, due to the environmental conditions specified under 3.7.6.

3.4.2.1 Chilled surfaces. All metallic surfaces of the tank and components

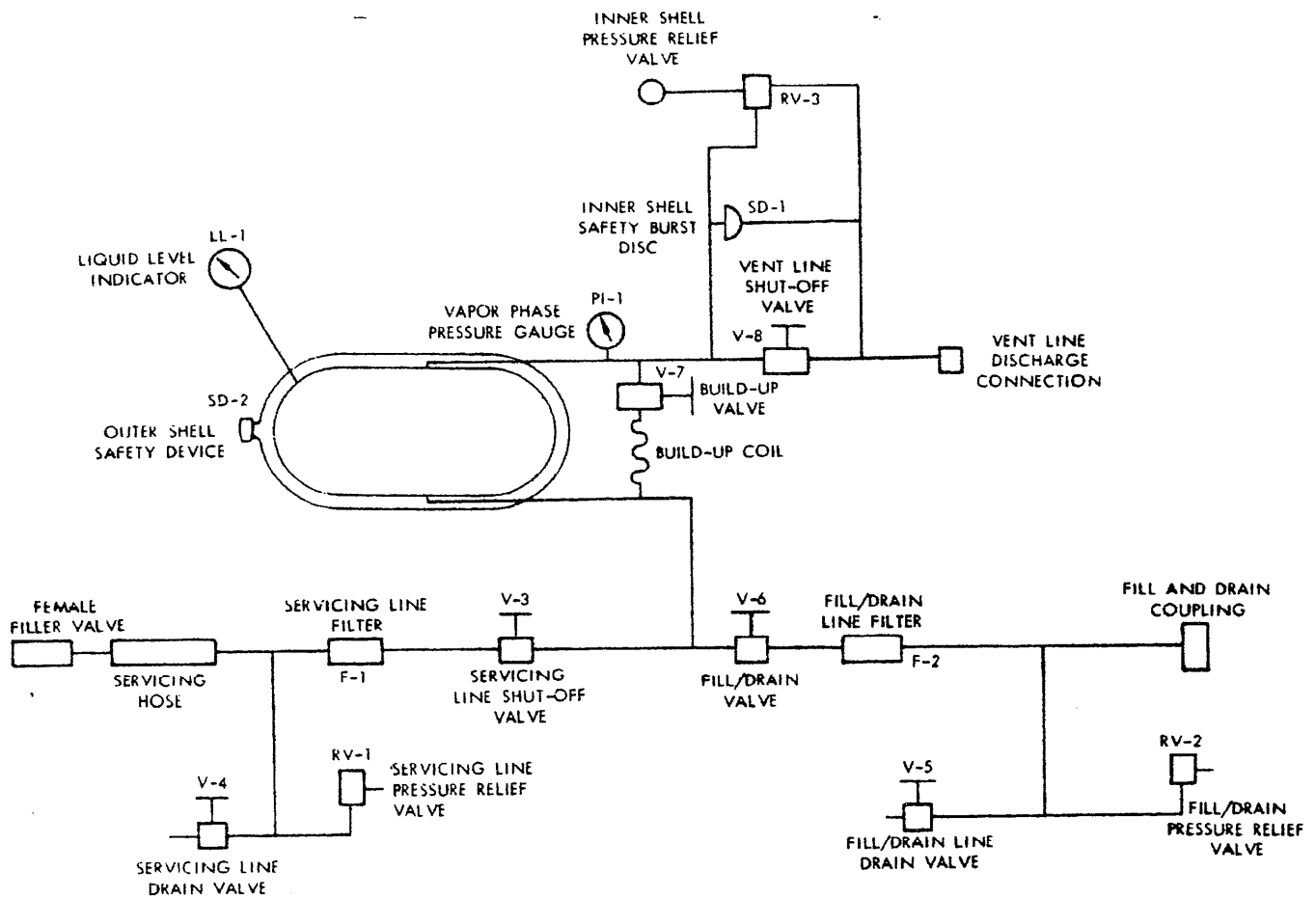


Figure 1 Schematic Diagram of Transfer Tank

thereof that contact high-purity oxygen or that tare in a location where they will be chilled sufficiently during operation to cause condensation of moisture from the atmosphere shall be fabricated from corrosion-resistant materials that require no paint or other organic chemical coatings to protect them from corrosion.

3.4.2.2 Dissimilar metals. Unless protected against electrolytic corrosion, dissimilar metals shall not be in intimate contact with each other. Dissimilar metals are defined in MIL-STD-889.

3.4.3 Gasketing and insulating materials. Plastic, rubber, or similar gasketing and insulating materials shall be compounded to insure their suitability for the intended application and, where applicable, their resistance to hydrocarbons or low temperatures.

3.4.3.1 Nonmetallic components. Packings, gaskets, seals, and other non-metallic components that come into contact with high-purity oxygen shall be compounded of materials compatible with use in a pure oxygen atmosphere under the conditions to which they will be subjected, and that are not adversely affected or deteriorated by continued use in an oxygen atmosphere. Polytetrafluoroethylene gasketing material for other than the 8987832 gasket shall be impregnated with not less than 25 percent pulverized glass fiber to improve its dimensional stability under compression.

3.4.4 Rubber goods. All rubber goods such as door seals, et cetera, shall be fabricated from rubber compounds conforming to MIL-R-3065 in order to insure their resistance to ozone attack.

3.4.5 Design. The tank shall be a complete, self-contained, liquid oxygen transport, storage, and servicing unit including all parts, controls, instruments, and accessories, designed for:

- a. Being filled with liquid oxygen at a supply location
- b. Being air transported while filled with liquid oxygen and pressurized to 50 pounds per square inch gage (psig)
- c. Transporting the liquid oxygen about an airbase
- d. Storing the liquid with low evaporation loss rates until needed, and at that time servicing the liquid into aircraft converters.

3.5.1 Configuration. The tank configuration shall be that of a tow wheeled trailer with a steerable swing-up-type retractable landing gear. The landing gear configuration shall be such that the tank assembly can only be towed with the landing gear in the retracted position. The latch or PIN used to retain the landing gear in position shall be fabricated from corrosion resistant material. The tank assembly shall be designed to meet the requirements of MIL-M-8090 as specified for type II, group A mobility (see 6.2).

3.5.1.1 Storage attitude. The tank shall be capable of being stored in a tilted position (towbar end down) regardless of the level of fill with the

front wheel retracted. A protective bumper shall be provided if required to prevent damage to any component of the tank which may result from repeated dropping of the towbar end while the tank is resting on the two main wheels.

3.5.2 Reliability The tank shall have a reliability (probability of successful operation of not less than 0.96 at 0.87 confidence (see 6.3.1).

3.5.3 Maintainability. Parts and assemblies shall be located and mounted to provide adequate clearance for repair and other maintenance and, where practicable, to permit removal and replacement of any part or assembly by removing or disconnecting only mounting bolts or fasteners, panel doors, tubing, or control cables to the part or assembly being removed. The equipment shall be designed and constructed in accordance with the design guidelines of MIL-STD-470, paragraph titled Establish Maintainability Design Criteria, except rather than being merely considered, the guidelines shall be applied wherever appropriate to the subject class or type of equipment and wherever they do not conflict with other requirements specified herein. Where practicable, the design and construction of the tank shall permit maintenance and servicing under adverse weather extremes. All maintenance, servicing, and adjustments which may be economically practicable at lower than depot level shall be capable of being performed using only common handtools and maintenance equipment commonly expected in shops doing maintenance on similar equipment.

3.5.3.1 Operating clearance. To the maximum practicable extent, maintainability provisions shall incorporate features insuring operating clearance for facilitating maintenance and servicing at low ambient temperatures by personnel wearing heavy gloves or mittens and handicapped by bulky clothing and footgear.

3.5.3.2 Intricate devices. Intricate locking devices, controls, and threaded fastenings that can be easily overtorqued by personnel lacking feel through thick gloves or numbness shall be avoided where possible.

3.5.3.3 Cover and Plate Fasteners. Covers and plates that must be removed for component adjustments or for component or part removal shall be easily removed using standard tools.

3.5.3.4 Maintenance downtime. The equipment shall be designed and constructed to permit maintenance by military service maintenance technicians in not more than the downtimes specified in 3.5.3.4.1 and 3.5.3.4.2. Not more than two technicians shall be required simultaneously for any task.

3.5.3.4.1 Corrective maintenance downtime. The mean corrective maintenance downtime for all levels of maintenance below depot maintenance shall be not more than 45 minutes with a related maximum corrective maintenance downtime of not more than 2 hours.

3.5.3.4.2 Maximum preventive-maintenance downtime. Maximum preventive maintenance downtime, excluding depot maintenance and major overhaul, shall be not more than 2 hours at the 0.9 percentile point.

3.5.4 Transport acceleration and vibration forces. The tank shall be designed to withstand the transport acceleration and vibration forces specified under 3.7.4.

3.5.5 Hoisting and tiedown attachment devices. Tiedown devices for compliance with MIL-A-8421 shall be provided. These shall include four or tire tiedown ring assemblies conforming to Drawing 48B7796. The tiedown devices shall serve for both tiedown and hoisting, and shall permit hoisting of the complete assembled tank filled to design capacity with liquid oxygen, considering vertical accelerations of 3 gravitational units (g). The rings shall be so located on the tank that transportation personnel can easily rig safe slings from common cable and spreader bar components for hoisting by a single-hook overhead crane.

3.5.6 Liquid loss. The tank shall be designed to insure the minimum practicable loss of oxygen for purging, cooldown, pressure building, et cetera.

3.5.7 Common parts. The tank shall be designed to provide for the maximum practicable interchangeability of hardware and fastening devices by using the minimum number of types and sizes of bolts, screws, nuts, washers, and other common hardware.

3.5.8 Detachable fittings. Wherever practicable, the tank shall be designed to include readily detachable- and attachable-type fittings in the liquid and vapor lines to permit rapid component removal and replacement. Disconnect points shall be clearly indicated and identified.

3.5.9 Protective covers. All cover plates, gaskets, and fittings necessary for protection of contained apparatus during operating, storage, and shipment of the tank shall be provided.

3.5.10 Lubricants. The tank shall be designed to fully comply with the requirements specified herein when components needing lubrication are serviced with military specification or federal specification lubricants in accordance with MIL-STD-838.

3.5.11 Cold weather operation. The tank shall be designed for full operational use in any ambient (see 6.3.3) temperature between -650 and +125°F without special provisions for winterization.

3.6 Construction. The tank shall be constructed to withstand the strains, shocks, vibrations, and other detrimental conditions incident to operation, maintenance, shipping, and storage with minimum loss of service time for maintenance, repair, and periodic servicing.

3.6.1 Foolproofness. Where improper installation of an item could cause malfunctioning of that item or the system in which it is installed, and unsymmetrical mounting means shall be provided. This mounting shall be so designed that the item can only be installed in its proper operating position.

3.6.2 Component mounting. Components that need not be removed or repositioned for use shall be securely mounted to the liquid storage tank assembly or other major components in a manner that will insure against damage or unnecessary movement during operation and transport. All subbases and other fixtures needed for safe and secure component mounting shall be provided and installed.

3.6.3 Tubing and lines. Tubing and lines shall be located in protected positions, securely fastened to frame or body structures, and provided with metal protective loom or grommets at each point where they pass through members, except where a through-the-frame connector is provided.

3.6.4 Pressure vessels. Unless otherwise specified herein, the liquid storage tank assembly, piping, and connections thereto shall be fabricated in accordance with section VIII of the ASME Boiler and Pressure Vessel Code.

3.6.5 Control panel. A control panel shall be provided and shall be of sufficient size for installation of the instruments and controls needed in normal tank use. It shall be so installed on the tank that all instruments, controls, et cetera, mounted thereon will be readily visible and accessible to an operator standing on the ground in front of the control panel. All valve handles and gage faces shall be not less than 27 inches above ground level. Whenever practicable, instruments that must be monitored in making a control adjustment shall be so located that an operator or maintenance man can simultaneously make the control adjustment and adequately read the related instrument.

3.6.5.1 Protection. The control panel shall be protected by a panel or door when the tank is not in use for liquid transfer.

3.6.6 Controls, instruments, and accessories. All automatic and manual controls, instruments, fittings, safety devices, and accessories needed for safe and efficient operation of the tank shall be provided.

3.6.6.1 Instruments. All instruments necessary for indicating the information needed in controlling the equipment and determining its performance shall be securely mounted on the control panel.

3.6.6.2 Controls. Insofar as practicable, all manually operated controls used in normal operation of the equipment shall be located on the control panel.

3.6.6.3 Installation. The controls, pressure gages, and instruments shall be installed in locations where they will not be contacted by liquid oxygen leaking from lines or connections and where water cannot drip on them as a result of vapor condensing on cold lines.

3.6.7 Parts fabrication. Sheet-metal parts shall be of such thickness, rigidity, and strength as to withstand dents, warping, vibration, radiated heat, et cetera, encountered in service and maintenance and under the conditions specified herein.

3.6.8 Locking devices. Where practicable, all screws, pins, bolts, et cetera, shall be equipped with locking devices. Safety wire, self-locking nuts, cotter pins, lock-washers, et cetera, will be acceptable. Where practicable, lock-washers shall be secured to bolts or screws. Cotter pins shall be fabricated from corrosion-resistant steel or other corrosion-resistant material.

3.6.9 Thread sealer. Tape conforming to MIL-T-27730 or other pipe thread sealing materials specifically approved by the procuring activity shall be applied to threads prior to assembly of all pipe threaded fittings subject to contact by liquid or gaseous oxygen. The tape shall be applied starting with the third thread to prevent contaminating the system.

3.6.10 Cleaning solvent drains. Provisions shall be included to insure that cleaning solvent and flushing liquids can be readily and thoroughly removed from the liquid storage tank assembly, from the pressure buildup system, and from the associated tank piping and components following cleaning operations. The use of readily removable and replaceable threaded plugs or similar devices in locations where it would be impractical to provide drain valves will be acceptable.

3.6.11 Pressure relief devices. Pressure relief devices shall be provided in any line or component that can be so isolated by closing valves, or otherwise, that dangerous pressures could develop. All pressure relief devices shall be installed at readily accessible locations. Provisions shall be incorporated to insure discharge of pressure without damage to equipment or danger to personnel. Safety valves shall be sized and selected in accordance with section VIII of the ASME Boiler and Pressure Vessel Code.

3.6.12 Special operation and maintenance tools. When specified (see 6.2), a complete set of all special tools, other than common handtools and tools normally available in motor vehicle repair shops, required for proper operation and maintenance of the tank and its components shall be provided.

3.6.13 Certification of welders. All welding shall be accomplished by welders certified in accordance with MIL-STD-1595.

3.7 Performance. The tank shall meet the requirements specified herein when tested in accordance with the test methods specified under 4.6.

3.7.1 Storage capacity. Under the conditions specified herein, the tank shall store not less than 50 U.S. gallons of 99.5 percent pure liquid oxygen at its atmospheric pressure boiling temperature. The liquid storage tank assembly shall have an internal volume of not less than 55 U.S. Gallons in order to provide an expansion (vapor) space of not less than 10 percent of the total design capacity.

3.7.2 Heat leak evaporation rate. The tank heat leak evaporation loss shall not exceed the equivalent of 14 pounds of oxygen per 24-hour day when:

- a. The tank inner shell is filled to not less than 50 percent of design capacity with liquid oxygen or liquid nitrogen at atmospheric pressure
- b. The tank is in a location where the ambient temperature is not less than
- c. The upper surface of the tank is continuously exposed to solar or equivalent heat radiation of 100 to 120 watts per square foot for not less than 8 hours each day

d. Not less than 30 days have elapsed since evacuation of the tank annular space, and

e. The tank has been subjected to all nondestructive test specified herein.

3.7.3 Air transporatability.

3.7.3.1 Flight and taxiing acceleration forces. The tank shall withstand the air transport flight and taxiing acceleration forces specified in MIL-A-8421, except that the lateral loads shall be 3g instead of 1.5g, when empty or filled with liquid oxygen to any level up to and including design capacity.

3.7.3.2 Vibration forces. The tank shall not be damaged by the vibration forces specified under method 514 of MIL-STD-810 for class 6 equipment when empty, or filled with liquid oxygen to any level up to and including design capacity.

3.7.3.3 Emergency landing acceleration forces. The tank shall withstand the emergency landing load shock force specified in MIL-A-8421 when filled with liquid oxygen, except the shock pulse shall be an approximate one-half sine wave of not less than 30 milliseconds (MS) or more than 40 ms duration. The peak acceleration of the shock pulse shall be not less than 18g for all three directions of shock input.

3.7.3.4 The fully loaded tank shall withstand like forces as imposed by the flight and taxiing acceleration loads specified in 3.7.4.1 while being transported on a railroad car, seagoing vessel, or truck.

3.7.4 Aircraft servicing performance. The tank shall service not less than 1 gallon per minute (gpm) through the servicing line, hose, and both halves of an aircraft liquid oxygen filler valve with a tank pressure of 30 ± 5 psig.

3.7.5 Mobility. The tank shall be capable of type II, group A mobility in accordance with MIL-M-8090 with exception of the 50 pound (lb) per ton towing force requirement (see 6.2).

3.7.6 Environmental conditions. The tank shall operate under and withstand the following environmental conditions without damage:

3.7.6.1 Operating temperatures. The tank shall perform all functions required herein in any ambient temperature between -650 and +125°F, including exposure to solar, or equivalent heat radiation of 100 to 120 watts per square foot at the higher temperature, without shelter or external winterization provisions.

3.7.6.2 Storage temperature. The tank shall not be damaged by storage in any ambient temperature from -80° to +160°F for not less than 72 hours.

3.7.6.3 Humidity. The tank shall not be damaged by operation or storage in any relative humidity up to and including 100 percent, including conditions wherein condensation takes place in the form of water and frost.

3.7.6.4 Fungus. The tank shall not be damaged by exposure to moist fungus growth such as encountered in tropical and subtropical climates.

3.7.6.5 Salt atmosphere. The tank shall not be damaged by operation or storage in an atmosphere containing salt-laden moisture such as encountered near bodies of salt water and in transportation on shipboard.

3.7.6.6 Rain. The tank shall not be damaged by operation or storage under heavy rainfall as encountered in any locale, including the tropics.

3.7.6.7 Sand and dust. The tank shall not be damaged by operation or storage in an atmosphere containing airborne sand and dust particles such as encountered in normal and desert operations.

3.7.6.8 Wind. The tank components shall not be damaged by storage and operation in wind velocities of Up to and including 70 miles per hour (mph).

3.8 Details of components.

3.8.1 Liquid storage tank assembly.

3.8.1.1 Liquid storage tank assembly components. The liquid storage tank shall be interchangeable, and shall be removable from the control housing assembly and the chassis, and shall consist of the following:

- a. Inner shell
- b. Outer shell
- c. Inner shell suspension system
- d. Insulation
- e. Piping and connections
- f. Safety devices

3.8.1.2 Fabrication. The liquid storage tank assembly shall be a welded vessel designed and fabricated in accordance with section VIII of the ASME Boiler and Pressure Vessel Code to contain, and retard evaporation loss of, liquid oxygen as necessary to insure compliance with the performance requirements specified in 3.7.1 and 3.7.2. In addition, the inner shell shall be certified under the code for the specified working pressure.

3.8.1.2.1 Component arrangement. The liquid storage tank assembly shall be fabricated with the inner shell suspended within the outer shell to maintain a vacuum-tight annular insulation space of sufficient distance between corresponding points on the shells and heads to meet the requirements specified herein.

3.8.1.3 Inner shell. The inner shell shall physically store the liquid oxygen. Insofar as practicable, it shall be designed to have the minimum surface area consistent with the requirements specified herein. The inner

shell shall have a smooth inside bottom surface throughout an arc of not less than 6 inches on each side of the vertical centerline for the entire length of the inner shell to insure complete drainage with the liquid fill-drain line specified in 3.8.1.7.1.1.1.

3.8.1.3.1 Inner shell attachments. The inner shell shall be equipped with all parts, fittings, attachments, and accessories necessary to provide for support, liquid transfer, total draining, venting, safety, and determination of liquid level.

3.8.1 .3.2 Inner shell material. The inner shell shall be fabricated from material with sufficient strength, rigidity, and vacuum-holding properties to insure compliance with the requirements specified herein, and that is resistant to corrosion caused by contact with liquid or gaseous oxygen, liquid or gaseous nitrogen, moist air, water, or cleaning solvents such as trichloroethane.

3.8.1.3.3 Inner shell design pressure. The inner shell shall be designed and constructed for a maximum working pressure adequate to permit the vapor space pressure relief valve setting specified in 3.8.1 .9.3 and for a normal working pressure of not less than 50 psig for transferring and servicing liquid oxygen under the conditions specified herein. Design and construction shall also be such as to insure against:

- a. Distortion or damage when the liquid storage tank assembly annular insulation space is evacuated to a high vacuum or is pressurized to the outer shell pressure relief device maximum opening pressure, and,
- b. Collapse of or damage to the inner shell when it is evacuated to an absolute pressure of 100 microns mercury (Hg) or less with the annular insulation space at atmospheric pressure.

3.8.1.4 Outer shell. The outer shell shall provide support for the inner shell and inner shell suspension system. The underside of the outer shell shall be reinforced as necessary to comply with the requirements specified herein.

3.8.1.4.1 Outer shell material. The outer shell shall be fabricated from material having sufficient strength, rigidity, and vacuum-holding properties to insure compliance with the requirements specified herein.

3.8.1.4.1.1 The outer shell sections through which piping connections to the inner shell pass shall be fabricated from material resistant to corrosion caused by contact with oxygen, nitrogen, moist air, salt atmosphere, or water, to protect against corrosion in case the protective coating is damaged by the extreme changes in temperature that it must undergo on and adjacent to the lines carrying liquid and cold vapors. Corrosion-resistant, low thermal conductive sleeves may be used to thermally isolate the liquid and vapor-carrying lines from the outer shell.

3.8.1.4.2 Design pressure. The outer shell shall be designed and constructed for a working pressure that will insure sufficient strength and rigidity to prevent distortion or damage when the annular insulation space is evacuated to a high vacuum, or pressurized to the outer shell pressure relief device maximum opening pressure.

3.8.1.4.3 Vacuum. The outer shell shall be provided with a vacuum fitting designed for effective evacuation of the annular insulation space and shall serve as the outer shell safety relief.

3.8.1.5 Inner shell suspension system. The liquid storage tank assembly inner shell shall be supported and positioned within the outer shell by a suspension system that will thermally isolate the inner shell from the outer shell and provide an annular insulation space as specified in 3.8.1.2.1.

3.8.1 .5.1 Strength. The inner shell suspension system shall be of sufficient strength and rigidity to solidly support and prevent damage to or unnecessary movement of the inner shell when it is filled to design capacity with liquid oxygen and subjected to the forces specified under 3.7.4.

3.8.1.5.2 Heat transfer resistance. The inner shell suspension system shall be fabricated from material possessing the maximum practical resistance to heat flow, and shall provide the minimum practicable heat transfer area between the liquid storage tank assembly inner and outer shells without sacrifice of necessary strength and rigidity.

3.8.1.6 Annular space insulation. The annular insulation space shall contain an insulation that will, together with evacuation of the annular space, insure compliance with 3.7.2. The-insulating material shall be of a composition that will not ignite or burn when heated to 400°F in 99.5 percent pure oxygen gas at a pressure of not less than 10 psig. Application of the insulation shall be such as to insure against settling or displacement in service.

*3.8.1.6.1 If a getter material is utilized in the annular space, it shall be secured in direct thermal contact with the inner shell. In addition, the getter material shall be of a type capable of being reactivated during evacuation at the temperature generated by the GSU-62M purging unit (220°F on the inner tank shell).

3.8.1.7 Piping and connections.

3.8.1 .7.1 Intertank piping connections. Piping and connections between the inner and outer shells shall be held to the minimum necessary for insuring safety and performance in accordance with the requirements specified herein. Connecting piping shall be of corrosion-resistant material possessing the maximum practicable resistance to heat flow and shall be installed to provide the maximum practicable length of heat transfer path combined with the minimum practicable heat transfer area.

3.8.1.7.1.1 Liquid Lines. A single internal fill-drain and service line shall be provided. Externally the line shall be connected to Provide separate liquid fill-drain and liquid service lines, valves, filters, and disconnects.

3.8.1 .7.1.1.1 Liquid fill-drain line. The liquid fill-drain line shall be sized and installed to provide for liquid oxygen flow or transfer into or out of the inner shell at a rate of not less than 10 gpm without the pressure drop through the line and filter exceeding 3 psig. The line shall terminate outside the control housing assembly in a 1-inch external pipe thread for installation of the disconnect coupling.

3.8.1 .7.1.1.1.1 Liquid fill-drain line installation. The liquid fill-drain line shall be connected to the bottom of the inner shell in a manner which will insure complete drainage of the inner shell into the line. In addition, the liquid fill-drain line installation shall be such as to:

- a. Insure against liquid entering from the inner shell when all liquid shut-off valves are closed and the tank is tilted up to and including 10 degrees about the lateral or longitudinal axis
- b. Minimize heat transfer between the inner and outer shells, and
- c. Expose the least practicable length of line outside the outer shell.

3.8.1 .7.1.1.1.2 Liquid fill-drain line shutoff valve. A manually operated shutoff valve having a free passage size approximately equal to that of the liquid fill-drain line inner diameter when fully open shall be provided in the line as near as practicable to the point where it enters the outer shell. The valve shall be so located and installed that liquid flow to the pressure build-up coil will not be restricted. General design and construction shall be as specified in 3.8.1 .10.1 through 3.8.1.10.1.4.

3.8.1 .7.1.1.1.2.1 Liquid fill-drain line shutoff valve mounting. The liquid fill-drain line shutoff valve shall be solidly mounted in a location readily accessible to an operator standing on the ground in front of the control panel. The valve shall be so mounted to supporting members that force applied in opening or closing the valve will not damage tank tank piping or connections. Mounting of the valve to supporting members shall be accomplished with material possessing the maximum practicable resistance to heat flow to reduce to minimum evaporation of liquid filled into the tank through the fill-drain line.

3.8.1.7.1.1.1.3 Liquid Fill-drain line disconnect coupling. 1/2-inch, male, liquid oxygen coupling half assembly consisting of a coupling seat, gasket, and cap conforming to Drawings C8987855, B8987832, and C8987869, respectively, assembled as shown on Drawing C8987830, shall be installed on the liquid fill-drain line external pipe thread specified in 3.8.1.7.1.1.1.

3.8.1.7.1.1.1.3.1. Liquid fill drain line disconnect coupling mounting. The disconnect coupling shall be solidly mounted as near as practicable to the fill-drain line shutoff valve in a location readily accessible to an operator standing on the ground outside the tank control housing assembly. The mounting location shall provide sufficient clearance around the coupling for use of strap wrenches or other tools to assist in installation or removal of the coupling, or attachment and uncoupling of liquid transfer hoses. The disconnect coupling shall be so mounted to supporting structures or members that a torque of 300 pound feet (lb ft) per inch of nominal line size applied to the coupling in either direction of rotation with a 24-inch wrench will not damage tank piping or connections. Mounting of the disconnect coupling to supporting members shall be accomplished with material possessing considerable resistance to heat flow to reduce to a minimum evaporation of liquid filled into the tank through the liquid fill-drain line. The coupling shall be located to provide clearance for attachment of liquid transfer hoses without interference between the fill-drain line hose or coupling and the servicing hose.

3.8.1 .7.1.1.1.4 Liquid fill-drain line filter. The liquid fill-drain line shall be provided with a filter through which all liquid entering or leaving the inner-shell through the fill-drain line must flow. The filter shall be located between the liquid fill-drain line shutoff valve and the disconnect fitting. The filter location shall be such as to insure ready access for inspection, cleaning, or removal.

*3.8.1.7.1.1.1.4.1 Liquid fill-drain line filter Performance. The liquid fill-drain line filter shall remove 98 percent by weight of all particles whose smallest dimensions is 10 microns or greater (10-micron nominal rating). The filter shall further remove all particles whose smallest dimension is 40 microns or greater (40-micron absolute rating). In addition, the filter element shall be sized to pass liquid oxygen at a flow rate of 25 gpm without the pressure drop exceeding 2 psig when the filter has previously ingested not less than 5 grams of particles having the following size distribution:

<u>Size of Particle (Microns)</u>	<u>Percentage by Weight</u>
10 to 20	36 \pm 3
20 to 40	24 \pm 3
40 to 60	16 \pm 3
Over 60	24 \pm 3

The filter shall not permit bypass of the element under any combination of conditions, and shall be capable of withstanding a pressure drop of 50 pounds per square inch (psi) across the element without damage.

***3.8.1.7.1.1.1.4.2 Liquid fill-drain line filter design.** The filter shall be of in-line configuration conforming to drawing 68B39474 with the element constructed from stainless steel or monel. Sintered or powdered metal material shall not be utilized unless backed up by a wire-wound or wire-mesh cloth element in which the wires have been fused under controlled conditions so as to positively prevent migration of particles that may be shed by the sintered or powdered metal portion. The filter element shall be fused to the housing in a manner which will prevent bypass of the element. Elastomeric seals shall not be used in the filter design or construction. The proper direction of flow shall be plainly marked on each side of the filter housing in a prominent location.

*3.8.1.7.1.1.2 Liquid servicing line. The liquid servicing line shall be sized and installed to provide for servicing liquid oxygen from the inner shell at a rate of not less than 2 gpm without the pressure drop through the line and filter exceeding 2 psig. The line shall be of minimum practicable length to minimize evaporation losses.

*3.8.1.7.1 .1.2.1 Liquid servicing line installation. The liquid servicing line installation shall be such as to:

- a. Insure against liquid entering the line from the inner shell when all liquid shutoff valves are closed and the tank is tilted up to and including 10 degrees about the lateral or longitudinal axis

- b. Minimize heat transfer between the inner and outer shells, and
- c. Expose the least practicable length of line outside the outer shell.

3.8.1 .7.1.1.2.2 Liquid servicing line shutoff valve. A manually operated shutoff valve having a free passage size approximately equal to that of the liquid servicing line inner diameter when fully open shall be provided in the line as near as practicable to the point where it enters the outer shell. The valve shall be so located and installed that liquid flow to the pressure build-up coil will not be restricted. General design, construction, and mounting shall be as specified in 3.8.1 .10.1 through 3.8.1.10.1.4.

3.8.1 .7.1.1.2.3 Liquid servicing line disconnect fitting. The liquid servicing line shall terminate outside the control housing assembly in a 3/4-inch external pipe thread oriented to discharge vertically upward, for attachment of the liquid servicing hose.

3.8.1 .7.1.1.2.3.1 Liquid servicing line disconnect fitting mounting. The disconnect fitting shall be solidly mounted as near as practicable to the servicing line shutoff valve in a location where it will be readily accessible for removal or attachment of a servicing hose, where the disconnect fitting will not be subjected to damaging bending or other stresses when the hose is secured in its storage provisions, and where there will be sufficient clearance around the fitting for use of strap wrenches or other tools to assist in servicing hose attachment or removal, or removal and replacement of the disconnect fitting itself. The disconnect fitting shall be so mounted to supporting structures or members that a torque of 300 lb ft per inch of nominal line size applied to the fitting in either direction of rotation with a 24-inch wrench will not damage tank piping or connections. Mounting of the disconnect coupling to supporting-members-shal~ be accomplished with material possessing considerable resistance to heat flow to reduce to a minimum evaporation of liquid serviced through the servicing line and hose. The fitting shall be located to provide clearance for attachment and use of the servicing hose without interference with other components.

3.8.1 .7.1.1.2.4 Liquid servicing line filter. The servicing line shall be provided with a filter identical to the one used in the liquid fill-drain line, and through which all liquid transferred from the tank through the liquid servicing hose must flow. The filter shall be installed between the servicing line shutoff valve and the servicing line disconnect fitting. The filter location and installation shall be such as to insure ready access for inspection, cleaning, or removal.

3.8.1 .7.1.2 Liquid Servicing Hose. One 10-Foot length of cryogenic liquid hose conforming TO MIL-H-83772 shall be provided with the tank. The internal pipe thread of the liquid servicing line. The other end of the hose shall be provided with a female liquid oxygen filler valve conforming TO MIL-V-38201.

3.8.1 .7.1.2.1 Liquid servicing hose storage provision. Provisions shall be incorporated on the tank assembly to store servicing hose in a coil. A tube of not less than 3 1/2 inches in diameter and not less than 8 inches long shall be furnished for protecting and storing the female filler valve while it

is still attached to the hose. The upper end of the tube shall be flared out in a minimum radius of curvature of one inch and incorporate a smooth edge that will not cut or otherwise damage the hose or filler valve. The lower end of the tube shall be covered with a solid plate containing drain holes to prevent the accumulation of water. Mounting of the storage tube shall be such that the servicing hose and valve will be protected from damage during tank acceleration and other use conditions specified herein.

3.8.1 .7.1.2.2 Liquid servicing hose bleed fitting. A bleed fitting shall be provided to permit purging of the liquid oxygen female filler valve and transfer hose prior to servicing. The fitting shall open the check valve of the female filler valve and shall discharge the gaseous and liquid oxygen below the control housing so that it will not impinge on the tank, its components, or operating personnel.

3.8.1.7.1.3 Vapor vent line. The vapor vent line shall be not less than 1 inch inside diameter, and shall be sized and installed to provide for:

a. Cooling down of the liquid storage tank assembly to permit filling as described below within 15 minutes, without the inner shell pressure exceeding 15 psig, after all components (including the inner shell) have stabilized at 125°F.

b. Filling the tank with liquid oxygen at any rate up to and including 10 gpm without the inner shell vapor pressure exceeding 15 psig when the tank is cold.

c* Venting liquid through the line when the inner shell is being filled and the tank contains between 50 and 52 gallons of liquid.

3.8.1 .7.1.3.1 Vapor vent line installation. The vapor vent line shall be installed to minimize heat transfer between the inner and outer shells. The line shall extend along the top inside of the inner shell and shall be so equipped with spray holes or similar provisions that cleaning fluid pumped into the inner shell through the vapor vent line will be sprayed against the inside top of the inner shell to flush sediment and other contaminant materials from the tanks.

3.8.1.7.1 .3.2 Vapor vent line shutoff valve. A manually operated shutoff valve having a tree passage size approximately equal to that of the vapor vent line inner diameter when fully open shall be provided in the vapor vent line as near as practicable to the point where it enters the outer shell. The valve shall provide positive shutoff when closed. General design, construction, and mounting shall be as specified in 3.8.1 .10.1 through 3.8.1.10.1.4.

3.8.1 .7.1.3.2.1 Vapor vent line shutoff valve mounting. The vapor vent line shutoff valve shall be solidly mounted in a location readily accessible to an operator standing on the ground in front of the control panel. The vapor vent line shutoff valve shall be so mounted to supporting members that force applied in opening or closing the valve will not damage the vapor vent line piping.

3.8.1.7.1.3.3 Vapor vent line discharge. The vapor vent line shall discharge toward the ground beneath the control housing assembly in a location where high

concentrations of gas and liquid overflow will not constitute a hazard or impinge or spray on other tank components. The line shall terminate in a 1-inch, female pipe thread in an area which is convenient for attachment of a hose from a purging unit in accordance with MIL-P-27456, or an overboard vent line during air transport.

3.8.1.8 Pressure buildup system. The pressure buildup system shall function to pressurize the tank assembly inner shell vapor space to 50 psig when the tank contains 2.5 gallons or more of liquid oxygen. It shall further be capable of pressurizing the tank inner shell vapor space to 50 psig within 10 minutes after closing the vapor vent line shutoff valve and initiating buildup when the inner shell is filled to between 15 and 20 percent of rated capacity and has been vented to atmospheric pressure for not less than 4 hours.

3.8.1 .8.1 Pressure buildup system components. The pressure buildup system shall consist of a vaporization coil and manual control valve, together with the connections, piping, mountings, instruments," and accessories needed for proper and safe operations.

3.8.1 .8.2 Method of operation. The pressure buildup system shall operate by vaporizing a portion of the liquid contained in the tank and pressurizing the inner shell vapor space with the resultant vapors. Vaporization of the liquid shall be accomplished in an atmospheric air heated coil that forms a direct external connection between the inner shell liquid and vapor phases through the pressure control system.

3.8.1 .8.3 Vaporization coil. The vaporization coil shall be designed and constructed to receive liquid from the tank and vaporize it at the rate necessary for compliance with the requirements of 3.8.1.8 by heat exchange with ambient air, and discharge the resultant vapors into the inner shell vapor space. The vaporization coil shall include all shrouding, baffling, and ducting necessary for insuring proper airflow distribution over the heat exchange surfaces.

3.8.1 .8.3.1 Vaporization coil materials. The vaporization coil and its associate piping, supports, attachments, and connections shall be constructed from materials not attached or adversely affected by contact with liquid oxygen or nitrogen, gaseous oxygen or nitrogen, water, dust, mud, moist air, or cleaning solvents.

3.8.1 .8.3.2 Vaporization coil installation. The vaporization coil shall be installed where it will be protected from adverse environmental conditions and mechanical damage. The" vaporization coil shall be connected in such a manner that it will function independently of the liquid fill line and liquid servicing line without interference or interdependence.

3.8.1 .8.4 Operating controls. Operation of the pressure buildup system shall require no control operation other than closing of the tank vapor vent line valve and opening of the pressure buildup manual control valve.

3.8.1 .8.4.1 All manually actuated controls used in normal operation of the pressure buildup system shall either be mounted on the control panel or easily accessible within the control panel housing.

3.8.1.9 Safety devices. Where necessary, pressure relief devices shall be provided for protection of the liquid storage tank and its associated components. All pressure relief devices and drains shall be installed in readily accessible locations and, except for the outer shell safety device, shall discharge all vented liquid or vapor toward the ground in a location which will insure against damage to equipment or danger to personnel and against creating fog where it will obscure controls, instruments, or fittings in the control housing assembly. All safety devices shall be fabricated from corrosion resistant materials which are not adversely affected by extended contact with oxygen, moist air, water or cleaning solvents.

3.8.1 .9.1 Inner shell safety head. A bursting-disc type safety head utilizing a readily replaceable disc in a union-type fixture shall be provided to relieve the inner shell vapor phase pressure to the atmosphere should this pressure become excessive and the pressure relief valve fail to open. The safety head relief pressure shall be not less than 1-1/2 times the inner shell maximum working pressure.

3.8.1 .9.1.1 Inner shell safety head installation. The inner shell safety head shall be installed with a sufficient length of tubing between itself and the vapor vent line to prevent frosting of the safety head unless the safety head actually ruptures to relieve the inner shell pressure. The discharge shall be into the vapor vent line between the vapor vent line shutoff valve and the vent line discharge.

*3.8.1 .9.2 Outer shell safety head. The outer shell safety head shall be as specified in 3.8.1.4.3.1.

3.8.1.9.2.1 Outer shell safety head installation. The outer shell safety head shall be installed on the end of the tank farthest removed from the control housing assembly. Design and installation shall be such that discharge from the safety head will be directed away from the control housing assembly and personnel adjacent thereto.

3.8.1 .9.3 Inner shell vapor space pressure relief valve. An automatic pressure relief valve shall be connected into the vapor vent line between the outer shell and the vent line shutoff valve to relieve inner shell excess pressure. The relief valve shall be designed to open at not less than 55 psig, and shall be sized to insure against the inner shell vapor space pressure exceeding 65 psig when:

- a. The tank is filled to not less than 90 percent of design capacity
- b. The tank is placed in an ambient temperature of not less than 125°F
- c. The buildup valve is left wide open
- d. All other valves are closed.

3.8.1.9.3.1 Inner shell vapor space pressure relief device installation. The inner shell vapor space pressure relief device shall be designed and installed in a manner that will prevent freezing of the relief device when venting oxygen vapor. The relief device shall discharge all vented material into the vapor vent line between the vent line shutoff valve and vent line discharge.

3.8.1 .9.4 Liquid fill-drain line pressure relief and drain valves.

3.8.1 .9.4.1 Pressure relief valve. An automatic pressure relief valve shall be provided in the fill-drain line between the shutoff valve and the disconnect coupling for venting excess pressure from the fill-drain line. The relief valve shall be designed to open at a pressure in excess of that at which the inner shell vapor space pressure relief valve opens, but less than the safe working pressure of the fill-drain line.

3.8.1 .9.4.2 Fill-drain line drain valve. A manually operated valve for draining liquid from the fill-drain line disconnect coupling when removing the fill hose shall be provided in the fill-drain line between the shutoff valve and the disconnect coupling, as near the disconnect coupling as practicable. The drain valve shall be located and installed to be readily accessible to an operator standing on the ground outside the tank control housing assembly. If practicable, the automatic pressure relief valve and the drain valve may be combined into one unit. The drain valve shall discharge beneath the control housing assembly.

3.8.1 .9.5 Liquid servicing line pressure relief and drain valves.

3.8.1 .9.5.1 Pressure relief valve. An automatic pressure relief valve shall be provided in the servicing line between the shutoff valve and the hose for venting excess pressure from the servicing line and servicing hose. The relief valve shall be designed to open at a pressure in excess of that at which the inner shell vapor space pressure relief valve opens but less than the safe working pressure of the servicing line and servicing hose.

3.8.1 .9.5.2 Servicing line drain valve. A manually operated valve for draining liquid from the servicing line and servicing hose shall be provided in the servicing line between the shutoff valve and the hose disconnect fitting as near the hose disconnect fitting as practicable. The drain valve shall be located and installed to be readily accessible to an operator standing on the ground outside the tank control housing assembly. If practicable, the automatic pressure relief valve and the drain valve may be combined into one unit. The drain valve shall discharge beneath the control housing assembly.

3.8.1 .9.6 Additional pressure relief valves. Additional automatic pressure relief valves shall be installed in each circuit or component not specified and which can be so isolated by closing valves or otherwise that a dangerous pressure could build up. These relief valves shall be designed to open at a pressure sufficiently low to insure against damage to the component or circuit affected. However, the operating pressure shall be in excess of that at which the inner shell vapor space pressure relief valve opens.

3.8.1.10 Controls.

3.8.1 .10.1 Shutoff and control valves. Shutoff and control valves shall be provided wherever needed for control of the inner shell vapor phase pressure, vapor phase venting, liquid transfer, and tank instrumentation.

3.8.1.10.1.1 Valve design and construction. Valves shall be designed and constructed to provide positive shutoff when closed and minimum resistance to flow when open. The-globe valves of 1/2 inch and larger nominal size which handle low temperature liquid or gas shall incorporate renewable seats that can be removed and replaced without disassembling the valve body from the tank piping. The sealing discs or plugs for these valves shall also be renewable without replacing the valve stem. All valves handling low temperature liquid and gas shall be so designed that the packing gland is located not less than the distance specified in table I from the valve connection centerline. The stem and the stem housing on these valves shall either be fabricated from 18-8 stainless steel or other equally low heat conductive material, or the stem and stem housing shall be provided with 18-8- stainless steel or other equally low heat conductive material inserts equal in length to not less than one-half the distance specified in Table I. Liquid level gage control and other instrument control and isolation valves may be of conventional construction. The service fill, vent, and pressure build-up control valves shall be identical to and interchangeable with each other.

3.8.1.10.1.1.1 **Valve handles.** Each manually operated control or shutoff valve shall be provided with a tee, cross, or other easily turned type handle with a diameter equal to 3 inches per inch of valve nominal size, but not less than 1 inch.

3.8.1.10.1.1.2 Valve cycling and leakage performance. When closed with a torque of 60 -5 pound-inches (lb in.) per inch of nominal size, and with the valve body at either ambient temperature or the atmospheric pressure boiling temperature of liquid oxygen or nitrogen, the valves shall not leak more than 2 cubic inches of free air, oxygen, or nitrogen gas per hour per inch of nominal size from 50 psig to a downstream pressure of 0 psig. The valves shall be capable of not less than 2,000 cycles of operation (see 6.3.4) when subjected to a differential pressure of 50 psig while closed, including at least 1,000 cycles at ambient temperature and 1,000 cycles with the valve body at the atmospheric pressure boiling temperature of liquid oxygen or nitrogen, without adjustment, repair, or maintenance, and without the above specified leakage rate being exceeded before, during, or after the cycling.

TABLE I

Separation of Valve Packing Gland From Valve Connection Centerline	
Valve Nominal Size (In Inches)	Separation of Packing Gland From Connection Centerline (In Inches)
1/4	4
3/8	4
1/2	7
3/4	7
1	9
1-1/4	9
1-1/2	11
2	11
2-1/2	12
3	12

3.8.1 .10.1.1.3 Valve overtorque performance. The valves shall be designed and constructed to withstand a closing torque of 300 \pm 10 lb in. per inch of nominal size, with the valve bodies at either ambient temperature or the atmospheric pressure boiling temperature of liquid oxygen or nitrogen. Such operation shall not result in a parts failure or a leakage rate in excess of that specified in 3.8.1 .10.1.1.2 when subsequently closed with a torque of 60 \pm 5 lb in. per inch of valve nominal size.

3.8.1 .10.1.2 Valve material. The valves shall be fabricated from corrosion resistant material not adversely affected by extended contact with oxygen, nitrogen, argon, hydrogen, helium, moist air, water or cleaning solvents.

3.8.1 .10.1.3 Valve packing. Valve packing shall be of material safe for use in contact with liquid or gaseous oxygen, and that will effectively seal the valve stem without causing difficulty of operation.

3.8.1 .10.1.4 Valve mounting. All valves used during liquid transfer shall be so mounted and installed that they can be readily opened or closed, and so that their control handles will be readily accessible to an operator standing at the control panel. All valves shall be so mounted to supporting members or large size piping that force applied to the control handles in opening or closing the valves will not damage the tank piping, and so mounted that the operator will be protected from liquid spray if a fitting or coupling leaks or breaks.

3.8.1.11 Tank instrumentation. All instruments necessary for effective and safe operation of the tank shall be provided. These shall include the following:

3.8.1 .11.1 Liquid level gage. A liquid level gage designed for flush mounting on the control panel and having a dial diameter of not less than 2-1/2 inches shall be provided to indicate the quantity of liquid oxygen contained in the liquid storage tank assembly inner shell with a accuracy of \pm 3 percent of tank design capacity.

3.8.1 .11.1.1 Gage construction. If a differential-pressure-type liquid level gage is furnished, the gage design and construction shall be such that breakage of the glass face will not subject the sensing element to damaging pressures when the liquid storage tank assembly inner shell is pressurized to 55 psig.

3.8.1 .11.1.2 Graduations. The liquid level gage shall be graduated in gallons of liquid oxygen. The liquid-oxygen graduations shall be printed on the gage face in black on a white background.

3.8.1 .11.1.3 Liquid level gage mounting. The liquid level gage shall be securely mounted on the control panel in a position where it will be readily visible during liquid transfer or filling to an operator standing on the ground in front of the control panel.

*3.8.1 .11.1.4 Pulsation snubbers. If a differential-pressure-type liquid level gage is furnished, it shall be provided with restriction orifices in each sensing line to act as pulsation snubbers for preventing undue fluctuation of the indicating needle.

3.8.1.11.2 Vapor phase pressure gage. A pressure gage with a dial diameter of not less than 2-1/2 inches shall be provided for indicating the inner shell vapor pressure. The gage shall be designed for flush mounting, shall be graduated over approximately 270 degrees of the dial face, and shall be accurate to within 32 percent of full-scale range.

3.8.1.11.2.1 Range. The indicating range of the vapor phase pressure gage shall be approximately 1-1/2 times the normal working pressure of the tank inner shell, unless a higher range is necessary to prevent the indicator from moving off scale before reaching the relief pressure of the inner shell safety head and the vapor space pressure relief valve specified in 3.8.1.9.1 and 3.8.1.9.3.

3.8.1.11.2.2 Vapor phase pressure gage installation. The vapor phase pressure gage shall be securely mounted on the control panel in a position where it will be readily visible during liquid transfer or filling to an operator standing at the control panel. The gage shall be so installed that no combination of valve or control settings can interfere with it indicating the inner shell vapor space pressure.

3.8.1.11.2.3 Pressure sensing tap. A tap shall be provided in the pressure gage line for attachment and use of external test equipment. The tap shall terminate in a -4 size flared tube connection conforming to MS33655 installed on the control panel near the pressure gage. The fitting shall be sealed with an AN929-4 cap assembly.

3.8.2 Control housing assembly. A sturdy, heavy-gage, sheet metal housing assembly shall be fabricated on the opposite end of the tank from the lumette eye. The housing shall contain and provide protection for the tank controls, instrumentation, and accessories.

3.8.2.1 Control housing assembly design and construction. The control housing assembly shall be designed and constructed to protect the enclosed components from mechanical damage, direct solar radiation, rain, sleet, snow, mud, sand, and other adverse weather, and environmental conditions. The control housing assembly shall be so constructed that it, or applicable sections thereof, can be readily removed from the liquid storage tank assembly for maintenance or removal of components.

3.8.2.1.1 The control housing assembly shall be constructed from material resistant to corrosion caused by wetting with condensed water, and so that retention of condensed water within the control housing will be effectively prevented.

3.8.2.1.2 If practicable, the top of the control housing assembly and the tops of all protuberances therefrom shall be shaped and slanted to resist the retention of snow, rain, or sleet. Doors and panels that must be opened for use of the tank shall be so constructed and installed that snow or ice will not lodge thereon in a manner that will prevent easy operation or access.

3.8.2.2 Size. The control housing assembly shall be of sufficient size to provide ready access to the enclosed components for operation, servicing, maintenance, and repairs, and to provide space for the storage of accessories and tools.

3.8.2.3 Access openings. Doors or hinged panels shall be provided in the control housing assembly as necessary for access for operation, inspection, servicing maintenance, and repair of the equipment. The doors and hinged panels whose positions may have to be regulated shall be provided with means for securing them in any position from fully closed to wide open when subjected to wind gusts up to and including 70 mph.

3.8.2.3.1 Hinges and latches. All doors and hinged panels shall be equipped with sturdy hinges and with latches that will hold them securely closed during storage. Latches shall also be provided for securely holding open the doors " and panels that must be opened for tank use. These latches shall securely retain the doors or panels in the set position even when subjected to wind gusts up to and including 70 mph.

3.8.2.3.2 Latches. The latches and regulating devices on all doors and hinged panels that must be opened for normal operation of the tank shall be readily operable by personnel wearing heavy arctic mittens.

3.8.2.4 Ventilation provisions. Ventilation openings or other air circulation provisions shall be provided in the control housing assembly as necessary to prevent accumulation of gases or the accumulation of fog resulting from moist air being chilled in the control housing during liquid transfer or tank filling. The ventilation openings shall be so located or shielded that the entrance of rain, snow, or other precipitation will be effectively prevented.

3.8.3 Chassis. The storage tank assembly shall include a two-wheeled trailer chassis with a retractable third wheel, designed and constructed to support the tank and other components specified herein. The trailer chassis shall be designed so that the third wheel has to be in the retracted position before the towing vehicle can be attached. The chassis shall conform to the requirements of MIL-M-8090 for Type II, Group A equipment (See 6.2). The chassis shall be designed to prevent damage to the tank assembly or other components when the tow bar is raised sufficiently to cause the back of the unit to touch the ground.

*3.8.3.1 Wheels, tires, tubes, and hubs. The two main wheels shall be equipped with size 6.00 X 9, 6-ply tires and tubes. The retractable wheel tire and tube shall be size 3.50-by-6, 4-ply.

3.8.3.2 Weight distribution. The weight shall be so distributed that when the fully loaded unit is parked on a level surface with the lunette eye 15 inches above the ground, not more than 85 pounds (lbs) or less than 65 lbs force applied at the lunette eye will be required to raise the landing gear clear of the supporting surface. In addition, the weight shall be distributed to insure a downward force on the lunette eye throughout a vertical range of 10 to 30 inches above the ground.

3.8.3.3 Parking brakes. The unit shall be provided with two-wheel, expandingshoe, automotive-type parking brakes. The control lever shall be located at the front of the unit near the lunette eye.

3.8.3.4 Suspension. The tank shall be solidily mounted to the running gear. The tire pressure shall be selected to be low enough to provide the necessary good riding qualities to prevent damage to the tank or its accessories without requiring springs. The tire pressure shall not exceed 15 psig.

3.8.3.5 Service brakes. Service brakes need not be provided.

3.8.3.6 Bumper. A rear bumper need not be provided.

3.8.3.7 Fenders. Fenders need not be provided.

3.8.3.8 Lighting devices and wiring. Lighting devices and wiring therefore need not be provided.

3.8.3.9 Mud flaps. Mud flaps need not be provided.

3.8.3.10 Pintle hook. A pintle hook need not be provided.

3.8.3.11 Safety chains, Safety chains need not be provided.

3.8.3.12 Towing in train. The unit need not be designed for towing in train.

*3.8.3.13 Reflectors. Reflectors need not be provided.

*3.8.3.14 Static discharge reel. A static discharge reel shall be provided on each storage tank assembly. The reel is to be capable of automatic retraction and the latching of the cable at any extended length. The length of the cable provided shall be 50 feet. The cable shall terminate in a grounding connector per MS27610.

3.8.4 Compartments.

3.8.4.1 Handbook and record compartment. A compartment shall be provided integral to each end item for containing the equipment operation handbook and the equipment maintenance and inspection record. The compartment shall be weatherproof if not contained in an enclosure and a minimum size of 9 by 11-1/2 by 2-inches.

3.9 Part numbering of interchangeable parts. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirements of MIL-STD-100 shall govern the manufacturer's part numbers and changes thereto.

3.10 Dimensions. The overall dimensions of the tank shall not exceed the following when an access openings are closed:

	<u>Inches</u>
a. Length	90
b. Width	55
c. Height	40

3*11 Weight. The weight of the empty tank and its accessories, including the trailer chassis, shall not exceed 720 lbs.

3.12 Finishes and protective coatings.

3.12.1 Surfaces contacting oxygen. All surfaces, parts, fittings, et cetera, of the tank that will be in contact with high-purity oxygen shall be thoroughly cleaned in accordance with the methods in MIL-STD-1359 to remove all metal shavings, oil, grease, and other foreign material. No other cleaning, priming, or painting with organic materials shall be performed on these surface.

3.12.2 Exposed parts and surfaces. All exposed metal parts and surfaces, except parts and surfaces that contact high purity oxygen, shall be cleaned treated and finished to provide protection from the environment as specified herein.

3.12.2.1 Trailer chassis and wheel finis.h. The trailer chassis and wheels shall be finished per MIL-STD-808 as modified by SA-ALC DWG 7545352. The final finish painting shall be color Dark Green per FED-STD-595, Color No. 24052.

3.12.2.2 Storage tank and mounting devices. The exterior of the storage tank proper and its mounting devices shall be finished per MIL-STD-808 as modified by SA-ALC DWG 7545352. The final finish painting shall be color dark green per FED-STD-595, Color No. 24052.

3.12.2.3 Control housing finish. The control housing shall be finished per MIL-STD-808 as modified by SA-ALC DWG 7545352. The final finish painting shall be color dark green per FED-STD-595, Color No. 24052.

3.13 Operational markings.

*3.13.1 Tank marking. The tank shall be marked in accordance with the provisions of the AF Technical Order 35-1-3, Painting and Marking of USAF Aerospace Ground Equipment, unless specified otherwise herein.

3.13.1.2 The lettering USE AGE TOWING VEHICLE shall be applied with 1-inch silver reflective letters in a readily visible location on the front of the tank near the towbar.

3.13.2 Control marking. All valves, gages, controls, and indicators used in operation of the tanks all be identified by securely attached nameplates of such composition that exposure to oil, dirt, light, et cetera, will not fade or cause them to become eradicated. Tags shall not be used.

3.13.3 Warning plates.

3.13.3.1 A weatherproofed red warning plate containing the following information shall be provided adjacent to the liquid servicing line:

WARNING - TANK IS NOT TO BE FILLED
THROUGH THIS LINE - FOR
SERVICING ONLY.

3.13.3.2 A weatherproofed red warning plate containing the following information shall be provided adjacent to the vent line disconnect fitting:

WARNING - ALL VALVES MUST BE CLOSED AND AN OVER-
BOARD VENT LINE ATTACHED TO THE VENT
LINE DISCONNECT FITTING DURING AIR TRANS-
PORT .

3.13.3.3 A Weatherproofed, red warning plate cautioning against overinflation of the tires and containing instructions concerning the pressure to which they must be inflated for proper operation of the equipment shall be attached to the unit near each main wheel.

3.13.4 Operating and precautionary instructions. Brief operating and precautionary instructions shall be permanently affixed on or near the tank control panel. The instructions shall be clear, concise, and adequate to enable operation of the tank without damage to the equipment or injury to personnel. Instruction panels shall be made from sheet aluminum or sheet zinc of not less than 0.050 inch thickness, anodized or etched to produce raised makings with a black or other dark color background, and with a border of not less than 1/4 inch.

3.13.5 Transportation data plate. A transportation data plate shall be provided as specified in MIL-M-8090 except that the marking of the plate may be as specified in 3.13.4 (see 6.2).

3.13.6 Lifting instruction plate. An instruction plate containing all information necessary for transportation personnel to rig a safe lifting sling from common cable and spreader bar components and to safely lift the tank with a 3-g acceleration, shall be securely attached to the outside of the control housing assembly near the transportation data plate. The lifting instruction plate shall be of the same material and prepared in the same manner as the transportation data plate.

3.13.7 Color marking. The indicating scale of each instrument (pressure gage, differential pressure indicator, temperature indicator, liquid level indicator, et cetera) used for normal operation and control of the tank shall be permanently and plainly marked with green and red to show the proper operating and the other-than-proper-operating or danger zones respectively.

3.13.8 Insulation identification plate. An insulation identification plate containing all information necessary to completely identify the insulation material installed in the liquid storage tank assembly annular space shall be

permanently affixed in a readily accessible and protected location that will be within the control housing assembly when it is closed for transport or storage. The insulation identification plate shall be prepared in the same manner as the operation and precautionary instruction plate. If a powder-type insulation is utilized, the plate shall indicate the number of pounds of insulating material installed.

3.14 Identification of product. Equipment, assemblies, and parts shall be marked for Identification in accordance with MIL-STD-130.

3.14.1 Tank nameplate location. The tank nameplate shall be securely attached to the outside of the control housing assembly in a readily visible location.

3.15 Workmanship. All parts of the tank shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to the following:

- a. Freedom from blemishes, defects, burrs, and sharp edges
- b. Accuracy of dimensions, radii of fillets, and marking of parts and assemblies
- c. Thoroughness of soldering, welding, brazing, painting, and riveting
- d. Thorough removal of rust, slag, scale, flux, and other foreign materials from inside of the tank and from all piping, valve connections, filter housing, and other surfaces that contact the oxygen product
- e. Alignment of parts and tightness of assembly screws, bolts, rivets, et cetera
- f. That rivets are tight and properly headed.

3.16 General cleaning instructions. Following completion of fabrication and assembly operations, the tank shall be thoroughly cleaned and degreased to remove dirt; excess soldering, brazing, and welding flux; welding slag, scale, metal chips, loose or chipped paint, spilled chemicals and other foreign materials. Cleaning shall be performed on surfaces contacting oxygen in accordance with the methods and procedures outlined in MIL-STD-1359 and to meet the following requirements:

a. When the tank is filled to 90 percent or more of design capacity with filtered liquid oxygen or liquid nitrogen and allowed to set for not less than 2 hours, the residue remaining after evaporation of the first liter of liquid withdrawn through the fill drain line with its filter removed shall contain:

- (1) No solid particles with any dimension greater than 1000 microns.
- (2) No fibrous particle (See 6.3.3) with a length greater than 6000 microns.
- (3) No more than 25 milligrams total of both solid and fibrous particles.

b. When the liquid remaining in the tank after withdrawal of the 1 liter

sample specified above is discharged through the liquid fill drain line specified in paragraph 3.8.1 .7,1.1.1 and the filter specified in paragraph 3.8.1.7.1.1.1.4 at not less than 5 gallons per minute, the total amount of contaminant collected on the filter shall not exceed 0.1 gram.

3.16.1 Decreasing. Tank surfaces, parts, fittings, et cetera, that will be in contact with highpurity oxygen shall be degreased in accordance with procedures in MIL-STD-1359. Precautions shall be taken to insure that solvents do not contact parts fabricated from incompatible materials.

*Method A - Vapor decreasing process using 1,1,1 trichloroethane conforming to MIL-T-81533 in a standard commercial vapor degreaser or by blowing decreasing vapors into the component in such a manner that the vapor will condense on and properly clean all surfaces requiring degreasing. Operation of a commercial vapor degreaser shall be in accordance with the manufacturer's recommendations. Following the vapor decreasing treatment, all solvent shall be removed by baking in an oven; by pruging with hot, dry oil-free air or nitrogen; or by vacuum evacuation.

Method B - Solvent decreasing process, using 1,1,1 trichloroethane or commercial nitrogen-safe cleaning solvent at ambient temperatures to thoroughly wash all surfaces requiring decreasing. If the solvent contains more than 1 percent oil after cleaning and being drained from the component, the decreasing operation shall be repeated with clean solvent. Following the decreasing process, all solvent shall be removed by baking in an oven; by purging with hot, dry, oil-free air or nitrogen; or by vacuum evacuation.

Method C - Detergent decreasing processes, in which the components to be cleaned are washed with hot inhibited alkaline cleanser until free from oil, grease, and other contaminant materials. Following this treatment, all surfaces (internal and external) shall be rinsed thoroughly with fresh, clean, hot water and dried by blowing with filtered and dried oil-free air or nitrogen or by baking at a temperature of 250° to 300°F until all water is removed.

3.16.1.1 Petroleum and other flammable solvents shall not be used on such surfaces,

3.16.1.2 All cleaning materials and solvents shall be thoroughly removed from the tank components following the cleaning and decreasing process.

3.17 Lubrication. All tank machined bearing surfaces that are normally lubricated in operation and that do not come into contact with the contained product shall be thoroughly lubricated with the recommended military specification or federal specification lubricants to be ready for immediate operation.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the

inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests. The inspection and testing of the tank shall be classified as follows:

- a. Preproduction testing.....See 4.4
- b. Acceptance test.....See 4.5.

4.3 Test conditions.

4.3.1 Tools. Special tools and field equipment shall be used to the maximum practicable extent during testing. Use of these tools shall be sufficient to determine their usefulness. Instances where the special tools furnished are inadequate shall be recorded in detail.

4.3.2 Instrumentation.

4.3.2.1 Pressures. Pressures in excess of 1 millimeter (mm) Hg absolute and pressure differentials, except pressure drops in the fill and servicing lines, shall be measured by means of the pressure gages and differential pressure meters furnished as part of the tank.

4.3.2.1.1 Pressures in excess of atmospheric shall be recorded in pounds per square inch gage. Pressures up to and including atmospheric shall be reported in microns or millimeters of mercury absolute, as applicable. Differential pressures shall be reported in inches of water or inches of mercury, as applicable.

4.3.2.1.2 Barometric pressure. Barometric pressure shall be measured by a properly calibrated mercurial barometer and reported in millimeters of mercury absolute.

4.3.2.3 Temperatures. Temperatures shall be measured by appropriately located thermometers or thermocouples used with calibrated potentiometers. Temperatures shall be reported in degrees Fahrenheit.

4.3.3.1 Liquid. Liquid oxygen flow rates shall be determined by either of the following methods:

- a. Passing the liquid through a properly calibrated recording or totaling type liquid flowmeter designed to handle the liquid being measured.
- b. Collecting the liquid and weighing it on an accurate scale.
- c. Measurement of the liquid volume used over a measure time span.

4.3.3.1.1 Liquid flow rates shall be recorded in gallons per minute of the liquid at its atmospheric pressure boiling temperature.

4.3.3.2 Gas. Gaseous oxygen flow rates shall be determined by passing the material through a properly calibrated recording or total-type gas meter designed to handle the gas being measured.

4.3.3.2.1 Gaseous flow rates shall be converted to weight flow rates for the material hand-led and expressed in pounds per hour, pounds per minute, et cetera, as applicable.

4.3.4 Observations. During the progress of all tests, such characteristics as ease of control, pressure regulation, freedom from leaks, and ease of operation shall be observed to determine whether the tank complies with all requirements specified herein.

4.3.5 Test data.

4.3.5.1 Correction of data. If the tests specified herein cannot be conducted under the specified conditions, the tests may, upon approval of the proctoring activity, be conducted under other conditions and the performance under the specified conditions calculated from the test results obtained. The manner of calculation shall be demonstrated, and actual test data proving the correctness of the calculation methods shall be presented for review by the procuring activity.

4.3.5.2 Operational data. Operational data shall be recorded at the intervals specified under the individual test instructions. The data recorded shall include the following:

a. Liquid storage tank

- (1) Vapor phase pressure (psig)
- (2) Liquid level gage reading (gallons)

b. Servicing data

- (1) Pressure of liquid entering transfer hose (psig)
- (2) Flowmeter reading (gpm)
- (3) Pressure of liquid at end of transfer hose (psig)
- (4) Actual delivery rate of liquid (gpm).

4.3.5.3 Psychometric data. Wet- and dry-bulb temperature readings shall be recorded at the intervals specified under the individual tests.

4.3.5.4 Barometric pressure. The barometric pressure shall be measured and recorded at the intervals specified under the various test procedures specified under 4.6.

4.3.5.5 Tolerances.

4.3.5.5.1 Data on absolute pressures measured in the range from 0 to 10 microns Hg shall be accurate to within 0.5 micron Hg.

4.3.5.5.2 Data on absolute pressures measured in the range from 10 to 50 microns Hg shall be accurate to within 2 microns Hg.

4.3.5.5.3 Data on gage pressures measured in the range from atmospheric to 10 psig shall be accurate to within 1/2 psig.

4.3.5.5.4 Data on gage pressures measured in the range from 10 to 50 psig shall be accurate to within 1 psig.

4.3.5.5.5 Data on gage pressures in excess of 50 psig shall be accurate to within 2 percent of the actual numerical reading. "

4.3.5.5.6 Data on weights, weight flow rates, and volume flow rates shall be accurate to within 1 percent of the numerical reading.

4.3.5.5.7 Data on gas and vapor flow rates shall be accurate to within 1 percent of the numerical reading.

4.3.5.5.8 Data on temperature shall be accurate to within 2°F.

4.3.5.6 Pressure test record. A record of the pressures at which each tank component is tested and the length of time during which it is subjected to the pressure shall be retained.

4.3.6 Preliminary run-in. The nature and extent of running-in shall be determined by the manufacturer, and shall be performed Prior to the testing specified herein. All necessary adjustments other than normal control adjustments shall be made during this run-in and shall remain undisturbed thereafter.

4.4 Preproduction testing (see 6.2).

4.4.1 Test sample. One tank shall be subjected to the preproduction tests. specified in 4.4.3.

4.4.2 Test report. After the preproduction tests are completed, three copies of a test report prepared in accordance with MIL-STD-831 shall be supplied to the procuring activity.

4.4.2.1 Reliability and maintainability information. The following information shall be submitted as an appendix to the preproduction test report:

a. A description of and the appropriate information below concerning any preproduction tests that were conducted prior to those described in the preproduction test report and that were intended to apply to the contract.

(1) All failures, servicing, adjustments, maintenance, and irregular functioning shall be accumulated operating time, cycles, miles, or position in the test. procedure, as appropriate. Test conditions at the time of the events identified shall be recorded.

(2) Test operator and maintenance technician errors, test equipment and test facility failures, and other events that might act as grounds for a request that an equipment failure not be counted as a reliability failure, shall be recorded. Detailed descriptions of the events and the analysis to substantiate any such requests made shall be included and shall be clearly cross-referenced to each applicable failure.

(3) A summary of the engineering analysis and of any tests conducted to determine assignable causes for any or irregular functioning.

(4) A summary of the engineering analysis leading to any corrections made to design, construction, quality control, or other procedures, or leading to any corrections to be made to production items or proposed to be made. The summary shall also include an analysis of the predicted effectiveness of such corrections. Failures that have been corrected by design changes or by other means shall be counted as reliability failures until the corrections have been both analyzed and verified by test sufficiently to substantiate the effectiveness of the correction to the satisfaction of the procuring activity.

(5) Clock time and manhours required for each maintenance and servicing action taken during the tests. A brief description of the experience and qualifications of the personnel taking such actions shall be included. The information shall include a summary of the data resulting from the servicing and maintenance tests required by 4.6.16. In addition, the clock time and manhours required for actual access and disassembly time shall be recorded for any teardown inspections done for mechanical checks in accordance with 4.6.20. The number of parts and assemblies removed and causing interference shall be noted for each teardown and inspection made. Administrative time, such as filling out records, and logistics time, such as obtaining parts from stock need not be included.

(6) Test activity or contractor comments on item features or requirements that, if modified, should improve the item.

(7) Test activity or contractor comments on use or maintenance conditions to be avoided or cultivated to increase the reliability or useful life of the item.

b. Any of the above information that is already included in the preproduction test report body or in other documents submitted to the procuring activity need not be repeated in the information required by this paragraph, but clear reference to the location and to the date of submission of the data shall be included.

c. All table and column headings all abbreviations and symbols used shall be clearly defined where used or in a table of abbreviation and symbol definitions placed in the front part of the appendix.

4.4.3 Preproduction tests. The preproduction tests shall consist of all the tests described under 4.6.

4.5 Acceptance tests. The acceptance tests shall consist of the following:

a. Individual tests.....See 4.5.1

b. Sampling plans and tests.....See 4.5.2

4.5.1 Individual tests.

4.5.1.1 Spring-loaded relief valve test. Each spring-loaded relief valve shall be subjected to the test specified in 4.6.1.

4.5.1.2 Tank tests. Each tank shall be subjected to the following tests as described under 4.6:

a. Examination of productSee 4.6.2

b. Mechanical inspectionSee 4.6.3

c. Functional checkSee 4.6.4

d. Pressure testSee 4.6.5

e. Cleaning effectivenessSee 4.6.6

f. Individual article vacuum retention testingSee 4.6.9.2

g. Heat leak individual acceptance test.....See 4.6.10.2

4.5.2 Sampling plans and tests.

4.5.2.1 Bursting disc sampling tests.

4.5.2.1.1 Bursting disc lot. A bursting disc lot shall consist of discs manufactured under essentially the same conditions and submitted for inspection at substantially the same time.

4.5.2.1.2 Bursting disc sampling and test. Three bursting discs from each lot of fifty or less shall be selected at random and each subjected to a gradually increasing clean, dry, oil-free air or nitrogen pressure until it ruptures. In case a disc fails at a pressure outside the limits established by the tank manufacturer for compliance with the specification, five additional sample bursting discs from the same lot shall be tested in the same manner.

4.5.2.1.2.1 Bursting disc rejection and retest. If more than one of the original samples or any of the five additional sample rupture discs fail at pressure outside the specified limits, the entire lot shall be rejected.

4.5.2.2 Valve sampling test.

4.5.2.2.1 Valve lot. A lot shall consist of control valves manufactured under essentially the same conditions and submitted for inspection at substantially the same time.

4.5.2.2.2 Valve sampling and test. One of each type (same size, design, and construction) valve from each lot of one hundred or less shall be selected at random and subjected to the testing specified in 4.6.15. In case the valve fails to fulfill all specified requirements, three additional samples from the lot shall be tested in the same manner.

4.5.2.2.2.1 Valve rejection and retest. If any of the three additional sample valves fail to fulfill all specified test requirements, the entire lot shall be rejected.

4.5.2.3 Liquid filter sampling test.

4.5.2.3.1 Filter lot. A lot shall consist of filters manufactured under essentially the same conditions and submitted for inspection at substantially the same time.

4.5.2.3.2 Filter sampling and test. One filter from each lot of 80 or less shall be selected at random and subjected to the absolute and nominal rating testing specified in 4.6.14 and 4.6.14.2. In case a filter fails to fulfill all specified test requirements, two additional sample filters from the lot shall be tested in the same manner.

4.5.2.3.2.1 Filter rejection and retest. If either of the two additional sample filters fail to fulfill all specified test requirements, the entire lot shall be rejected.

4.6 Test methods.

4.6.1 Spring-loaded relief valve test. Prior to installation on the tank, each spring-loaded relief valve shall be subjected to a gradually increasing pressure of clean, dry, oil-free air or nitrogen at its inlet until it starts to discharge. The pressure shall then be reduced until the valve completely reseals. This procedure shall be repeated until the valve has started to discharge, and resealed, not less than twice. Following this testing, the valve shall be checked for leakage by application of a soap film across the outlet and over all outside surfaces with not less than the maximum working pressure of the component which the valve will be used to protect, being applied at the valve inlet. Failure to open or reseal within the specified limits or an indication of leaking during the soap film test shall be cause for rejection.

4.6.2 Examination of Product. The tank shall be inspected to determine whether it complies with the requirements specified herein with respect to dimensions, workmanship, finish, and marking. The tank shall be subjected to a thorough inspection to determine quality, ease of adjustment, alignment, and functioning of all parts.

4.6.2.1 Dimensions and weight. The overall dimensions and total weight, including all equipment and accessories, of the completely assembled empty tank shall be recorded on the test data sheets. The dimensions and weight shall not exceed the limits specified in 3.10 and 3.11.

4.6.3 Mechanical inspection. A mechanical inspection of all components and parts shall be conducted. All pertinent data concerning conditions, defects of manufacturers, damage in transit, and damage through use prior to test shall be recorded.

4.6.4 Functional check. All mechanical parts of the tank shall be checked for free and proper functioning.

4.6.5 Pressure test. Each component and circuit of the tank that operates under positive pressure in normal service shall be pressure tested in accordance with section VIII of the ASME Boiler and Pressure Vessel Code. Automatic pressure relief devices need not be installed for this test. Any distortion, damage, or leaks resulting from the pressure testing shall be cause for rejection of the components affected,

4.6.6 Cleaning effectiveness.

4.6.6.1 Visual inspection. All equipment, pipes, and components that will contact liquid oxygen shall be visually examined for evidence of corrosion products, metal chips, scale, weld scale, oil, grease, paints, preservatives, decals, or other contamination or foreign matter. Any evidence of contamination or foreign matter shall require recleaning and retest.

4.6.6.2 Ultraviolet light inspection. All accessible surfaces and parts that will contact liquid oxygen shall be visually inspected for hydrocarbons with ultraviolet light. Any evidence of fluorescence shall require recleaning and retest.

4.6.6.3 Particulate matter test. Following the cleaning and decreasing operations specified herein and equipment final assembly, the liquid storage tank inner shall be filled to not less than 90 percent of design capacity with liquid nitrogen. The tank shall then be permitted to set undisturbed for not less than 2 hours. Following the 2-hour period, the filter shall be removed from the fill-drain line and a 2-liter or larger Dewar flask placed under the discharge end of the fill drain line specified in 3.8.1.7.1.1.1, the shutoff valve opened, and not less than 1 liter of the first liquid discharged through valve opened, and not less than 1 liter of the first liquid discharged through the line collected in the Dewar flask. This sample shall be evaporated to dryness and the residue examined for particulate matter. The liquid storage tank and the associated piping and fittings shall be recleaned and this test repeated until the particulate matter remaining as residue contains:

- a. No solid particle with any dimension greater than 1,000 microns
- b. No fibrous particle with a length greater than 6,000 microns
- c. No more than 25 mg total of both solid and fibrous particles.

4.6.6.4 Total solids test. Following withdrawal of the 1-liter sample specified in 4.6.6.3, the entire load of contained liquid shall be discharged through the liquid fill-drain line specified in 3.8.1.7.1.1.1. and the filter specified in 3.8.1.7.1.1.1.4 at a rate of not less than 10 gpm. The filter shall be thoroughly cleaned and the removed material collected, dried, and weighed after each use. If more than 0.1 gram of contaminant material is collected on the filter during discharge of the liquid from the tank, the liquid storage tank assembly and the associated piping and fittings shall be recleaned. Cleaning and testing shall be repeated until the total amount of contaminant collected on the filter from discharging the specified liquid storage tank assembly load is less than 0.1 gram.

4.6.7 Liquid storage capacity test. The tank storage capacity shall be determined by filling a liquid into the inner shell with the tank setting on its wheels on a flat, level, surface until the filling liquid overflows through the vapor vent line specified in 3.8.1.7.1.3, recording the liquid level gage reading in terms of liquid oxygen, and then either measuring the volume of the filling liquid or determining its volume from weights before and after filling. The inner shell shall then be filled completely to determine total internal volume, and the quantity of filling liquid determined as above. The actual liquid volume when filled to overflow through the vapor vent line and when completely filled shall both be recorded in US gallons and shall be accurate to within 1/2 gallon. The tank storage capacity at which liquid starts to discharge through the vapor vent line and the total internal volume shall comply with 3.7.1 and 3.8.1.7.1.3 or the tank shall be considered to have failed the test.

4.6.8 Transportability and handling tests.

4.6.8.1 Air transport flight and taxiing acceleration forces. The completely assembled tank shall be filled to design capacity with a cryogenic liquid having a density of not less than 9.5 pounds per US gallon and pressurized to not less than 45 psig. While so filled and pressurized, the tank shall be subjected to the flight and taxiing acceleration force loads specified in MIL-A-8421, as modified by 3.7.4.1. Failure to satisfactorily pass the specified tests for demonstrating compliance with the requirements of 3.7.4.1 shall be cause for rejection.

4.6.8.1.1 Liquid nitrogen may be used as the filling liquid if the acceleration loads are increased to not less than 1.42 times the specified value.

4.6.8.2 Vibration. The complete tank, filled as specified in 4.6.8.1. shall be subjected to the vibration testing specified in method 514 of MIL-STD-810 for class 6 equipment. During and after each phase of the testing the tank, the test instrumentation and the data being accumulated shall be observed for resonance of piping, instruments, accessories, braces, brackets and other installed parts, devices, and equipment; loosening or loss of threaded, riveted, or other fasteners; and other damage or indications of impending failure shall be recorded on the test data sheets. Programed vibration testing not completed because of a failure or impending failure, including any remaining resonance dwell, shall be repeated after corrective action.

4.6.8.2.1 The tank shall be carefully examined after each test phase and following completion of the overall test. Fractures or bending of piping, braces, or brackets; fracture or failure of welded, brazed or soldered joints, connections, or fittings; loosening or loss of parts or of threaded, reveted or other type fasteners; damage to or loss of calibration in gages and other Instruments; or loss of vacuum in the annular space attributable to either out-gassing or leaks shall be considered a failure of the tank to pass the test.

4.6.8.3 Emergency landing acceleration forces. The completely assembled tank shall be filled to design capacity with a liquid having a density of not less than 9.5 lbs per US gallon and pressurized to not less than 45 psig. While so filled and pressurized, the tank shall be subjected dynamically to the emergency landing acceleration force loads specified in MIL-A-B421, as modified by 3.7.4*3. Breaking loose of the unit from its tiedowns, separation of a component from the main body of the unit, or any discharge of contained liquid beyond the tank envelope shall be cause for rejection.

4.6.8.4 Hoisting and tiedown provision test. The completely assembled tank shall be filled to design capacity with a liquid having a density of not less than 9.6 lbs per US gallon. Weights totaling not less than 2,220 lbs shall be so attached to the tank that the combined weight of the filled tank and the weights will be supported by the hoisting and tiedown rings when the tank is raised by an overhead crane. The tank and weights combination shall then be raised to a height of not less than 3 feet above the floor by a single-hook overhead crane using the hoisting and tiedown rings, held in that position for not less than 1 minute, and then lowered to the floor. This procedure shall be repeated three times. Any damage to or distortion of any tank component shall be cause for rejection.

4.6.9 Heat leak evaporation loss rate tests.

4.6.9.1 Initial preproduction test. The initial preproduction heat leak evaporation loss rate test shall consist of the following individual test operations conducted in the order listed. Throughout the complete test, the inner shell vapor phase pressure shall remain at as near atmospheric as necessary pressure drops through the measuring apparatus will permit.

4.6.9.1.1 With the tank filled to not less than 50 percent of design capacity with liquid oxygen or nitrogen, the tank shall be placed in a location where the ambient temperature will remain at not less than 125°F throughout the periods specified.

4.6.9.1.2 The inner shell vapor space shall be vented to atmospheric pressure for not less than 24 hours through the flow measuring apparatus that will be used for determining the evaporation loss rate.

4.6.9.1.3 The tank shall remain under the specified ambient temperature and vapor phase pressure conditions for an additional 72 hours while heat leak evaporation rate losses for the tank are determined by passing a-l vapors vented from the inner shell through a recording- or totaling-type gas flowmeter. During this 72-hour period, the upper surface of the tank shall be exposed to the full impact of solar or equivalent heat radiation of 100 to 120 watts per square foot for three separate periods of not less than 8 hours each, with each exposure followed by a period of not less than 16 hours during which no solar radiation is applied. The total weight of vapors vented during the test, the weight of vapors vented since the preceding reading, the average ambient temperature to which the tank has been subjected during the preceding period, and the

average barometric pressure to which the tank has been subjected during the preceding period shall be recorded at intervals of not to exceed 8 hours during the 72-hour test. The actual loss rate for each reading, the average actual loss rate over the entire 72-hour test period, and the average ambient temperature to which the tank was exposed during the 72-hour test period shall be calculated. The evaporation loss rates shall be reported as the pounds of liquid oxygen vaporized per 24-hour day, and shall not exceed the limit specified in 3.7.2, or the tank shall be considered to have failed the test.

4.6.9.1.4 Pressurized test and evaporation loss. The tank shall be removed from the high temperature test conditions and exposed to ambient temperature conditions for not less than 36 hours to permit temperature stabilization. The tank shall then be filled to not less than 60% of design capacity and pressurized to 30 psig and allowed to remain in this condition for a period of 7 days.

4.6.9.1.5 The tank shall then be subjected to the individual acceptance evaporation loss rate test specified in 4.6.10.2 to establish comparative data for determining whether production tanks are capable of complying with 3.7.2.

4.6.10.2 Evaporation loss rate individual acceptance test. With the inner shell filled to not less than 50 percent of design capacity, the tank shall be placed where it will be subjected to local or shop ambient temperature throughout the test. The inner shell vapor space shall be vented to atmospheric pressure for not less than 24 hours through the flow measuring apparatus that will be used for determining the evaporation loss rate. The heat leak evaporation loss rate for the tank shall then be determined by passing all vapors vented from the inner shell through a recording- or totaling-type gas flowmeter for an additional period of not less than 72 hours. Throughout the test, the inner shell vapor phase pressure shall remain at as near atmospheric as necessary pressure drops through the flow measuring apparatus will permit.

4.6.10.2.1 The total weight of vapors vented during the test, the weight of vapors vented since the preceding reading, the average ambient temperature to which the tank has been subjected during the preceding period, and the average barometric pressure to which the tank has been subjected during the preceding period shall be recorded at intervals of not to exceed 8 hours throughout the 72-hour test. The actual loss rate in pounds for each reading, the average actual loss rate in pounds over the entire 72-hour test period, and the average ambient temperature to which the tank was exposed during the 72-hour test period shall be calculated. The production item average loss rate for the 72-hour test period shall be corrected from the average temperature experienced during the test period to the average temperature at which the comparative data specified in 4.6.10.1.5 was obtained, and the result reported as the pounds of liquid oxygen vaporized per 24-hour day. This loss rate shall not exceed the limit established by the comparative data obtained in 4.6.10.1.5 for compliance with 3.7.2 or the tank shall be considered to have failed the test.

4.6.11.1 Buildup with low liquid level. The liquid storage tank assembly shall be filled with enough liquid oxygen or liquid nitrogen to insure between 2.5

and 3 gallons remaining in the inner shell after the specified stabilization. The tank shall then be set with the inner shell vapor space vented to atmospheric pressure for not less than 4 hours. Following this stabilization period, the inner shell vapor vent line shall be closed and the pressure buildup valve opened. The inner shell vapor phase pressure shall reach 50 psi or the tank shall be considered to have failed the test.

4.6.11.2 Pressure buildup time. The tank shall be filled with liquid oxygen to between 15 and 20 percent of capacity and permitted to set with the inner shell vapor space vented to atmospheric-pressure for 4 hours. The inner shell vapor vent line shutoff valve shall then be closed and the pressure buildup system actuated. The length of time required after closing of the vent valve until the vapor phase pressure has reached 50 psig shall be recorded on the data sheets and shall not exceed 10 minutes or the tank shall be considered to have failed the test.

4.6.12 Insulation combustibility. A sample of the insulation material used in the annular space shall be tested for combustibility as follows:

- a. Place approximately 0.5 gram of the material in an oxygen bomb
- b. Pressurize the oxygen bomb to not less than 10 psig with oxygen gas having a purity of 99.5 percent or better
- c. Raise the temperature of the oxygen bomb to not less than 400°F and hold at that temperature for not less than 1 hour. A sudden temperature rise, charring of the insulation material, or other evidence of ignition or burning of the insulation material shall be cause for rejection.

4.6.13 Liquid transfer tests.

4.6.13.1 Fill-drain line test. Liquid oxygen shall be transferred into the tank through the fill-drain line specified in 3.8.1 .7.1.1.1 at not less than 10 gpm for a length of time adequate to determine the pressure drop resulting from friction losses in the filter and line. The pressure drop shall not exceed 3 psig, or the tank shall be considered to have failed the test.

4.6.13.1.1 Liquid nitrogen may be used at a flow rate which will provide a pressure drop equivalent to that resulting from the specified liquid oxygen. If liquid nitrogen is used for this purpose, data shall be provided to substantiate the flow rate used.

4.6.13.2 Servicing line test. Liquid oxygen shall be transferred from the tank through the servicing line specified in 3.8.1 .7.1.1.2 at not less than 2 gpm for a length of time adequate to determine the pressure drop resulting from friction losses in the line and filter. The pressure drop shall not exceed 2 psig, or the tank shall be considered to have failed the test.

4.6.13.2.1 Liquid nitrogen may be used at a flow rate which will provide a pressure drop equivalent to that resulting from the specified liquid oxygen flow. If liquid nitrogen is used for this purposed, data shall be provided to substantiate the flow rate used.

4.6.13.3 Aircraft servicing rate test. With the liquid servicing hose specified in 3.8.1.7.1.2 attached to the servicing line disconnect, the female liquid oxygen filler valve shall be connected to a male liquid oxygen fill-buildup-vent valve conforming to MIL-V-25961. The tank vapor phase pressure shall be increased to $30 \pm$ psig with the pressure buildup system specified in 3.8.1.8, the servicing line shutoff valve shall be opened, and the servicing rate determined by flowing the contained liquid oxygen through the servicing line, the servicing hose, the female filler valve and the male fill-buildup-vent valve until the rate of flow has been established. The servicing rate shall be not less than 1 gpm or the tank shall be considered to have failed the test.

4.6.13.4 Vent line test. The tank shall be parked under conditions that will insure all liquid storage tank assembly components attaining a temperature of not less than 125°F. After the liquid storage tank components have stabilized at this temperature, liquid oxygen or liquid nitrogen shall be transferred into the inner shell through the fill line until the inner shell has cooled sufficiently to permit filling at the 10 gpm rate specified in 3.8.1.7.1.3. The rate of transfer during cooldown shall be the maximum that will maintain a liquid storage tank assembly inner shell pressure of less than 15 psig. Cooldown time shall not exceed 15 minutes, or the tank shall be considered to have failed the test. Following cooldown, the liquid storage tank assembly shall be filled at a rate of not less than 10 gpm. The inner shell vapor phase pressure shall not exceed that specified in 3.8.1.7.1.3 when filled at the specified rate, or the tank shall be considered to have failed the test.

4.6.13.5 Vapor relief capacity. Following the vapor vent line test specified in 4.6.13.4 and with the tank remaining filled to not less than 90 percent of design capacity, the vapor vent line shutoff valve specified in 3.8.1.7.1.3.2 shall be tightly closed, the pressure buildup system control adjusted for maximum buildup rate, and all other valves closed. The inner shell vapor space excess pressure shall be permitted to vent through the relief device specified in 3.8.1.9.3 until the inner shell vapor space pressure reaches its maximum reading. The vapor space pressure shall not exceed 65 psig under these conditions, or the tank shall be considered to have failed the test.

4.6.14 Filter tests.

4.6.14.1 Absolute rating. Compliance with the 40-micron absolute rating requirement of 3.8.1.7.1.1.4.1 shall be substantiated by the bubble point method as follows: The filter element shall be submerged in SOLOX 190, or equivalent, fluid. The fluid level shall be maintained at not to exceed 1/2 inch above the top of the element. The element shall be slowly pressurized from within with air or nitrogen gas and slowly rotated 360 degrees at each pressure increment increase. If the first bubble is emitted from the element at a pressure of less than 6 inches of water, the filter shall be considered to have failed the 40-micron requirement. The pressure shall be increased until the bubble point is determined.

4.6.14.2 Nominal rating. Compliance with the removal of 98 percent by the weight of all particles whose smallest dimension is 10 microns or greater as required

by 3.8. 1.7.1.1.1.4.1 shall be substantiated as follows: Following completion of the 50 cycle servicing test specified in 4.6.19, the filter shall be permitted to stabilize at 125°F without any intervening servicing, cleaning, adjustment, or repair. Approximately 10 liters per inch of filter nominal diameter or liquid oxygen or nitrogen previously filter through a 5-micron Millipore, or equivalent, membrane filter shall be contaminated with not less than 10 grams of particles with the following size distribution:

<u>Size of Particle (Microns)</u>	<u>Percentage by Weight</u>
10 to 20	36 ± 3
20 to 40	24 ± 3
40 to 60	16 ± 3
Over 60	24 ± 3

The liquid shall be placed in a container, agitated to insure a homogeneous mixture, and then transferred through the filter in a time interval of not more than 45 seconds. The filter shall be so positioned that the flow is vertically down and the discharge is directed into a clean, particle free, container with provisions to insure positive retention of any particles passing through the filter and exclusion of external particles. The liquid shall be permitted to vaporize, and the container flushed by use of a wash bottle containing approximately 200 milliliters (ml) of isopropylalcohol which has been previously filtered through a 5-micron Millipore, or equivalent, membrane filter. The wash solution shall then be filtered through a preweighed 5-micron Millipore, or equivalent, membrane filter. This container wash procedure shall be performed four, times, the wash solution each time being filtered through the membrane filter. The filter funnel shall also be washed with an additional 200 ml of solvent, and this wash solution passed through the membrane filter. Upon completion of the filtering, the membrane filter shall be dried, and weighed again. If the weight increase is more than 0.2 gram, the filter shall be considered to have failed the 98-percent retention of all particles 10 microns or larger.

4.6.14.3 Filter pressure drop. Liquid oxygen shall be transferred through the filter specified in 3.8.1.7.1.1.4 at a flow rate of not less than 25 gpm for a length of time adequate to determine the pressure drop through the filter after contamination. The liquid oxygen stream shall be contaminated with not less than 5 grams of particles of the size and composition specified in 3.8.1.7.1.1.1.4.1. The 5 grams of contaminant shall be introduced into the liquid stream at a rate of approximately 1 gram per minute. Introduction of the contaminant shall not require more than 4-1/2 minutes ± 30 seconds. The pressure drop after the filter has been so contaminated shall not exceed that specified in 3.8.1.7.1.1.1.4.1, or the filter shall be considered to have failed the test. The filter shall then be further contaminated with particles until a constant pressure drop of not less than 50 psig across the filter element is reached. Following this, the filter shall be opened and inspected. Any permanent distortion or damage incurred by the filter element or housing as a result of the 50 psig differential shall be cause for rejection.

4.6.14.3.1 Alternate test material. Water may be used at a flow rate which will provide a pressure drop equivalent to that resulting from the specified liquid oxygen flow. If water is employed for this purpose, data shall be provided to substantiate the flow rate used.

4.6.15 Shutoff and control valve tests. The valve shall be subjected to the following tests in the order specified:

4.6.15.1 Cycling. The valve shall be closed with a torque of 60 ± 5 lb-in. per inch of nominal size, and subjected to a compressed air, oxygen gas or nitrogen gas inlet pressure of not less than 50 psig with the outlet open to atmospheric pressure. The valve shall then be opened to not less than the three-fourths open position, after which it shall be again closed with a torque of 60 ± 5 lb-in. per inch of nominal size and the specified inlet pressure reestablished. This shall constitute 1 cycle. One thousand such cycles shall be accomplished without intervening valve lubrication, adjustment, or repair while the valve body is subjected to ambient temperature. The thousand-cycle test shall then be repeated with the valve body submerged in liquid oxygen or liquid nitrogen. Damage to or improper operation of the valve as a result of this test shall be cause for rejection.

4.6.15.2 overtorque. At the conclusion of the cycling test specified in 4.6.15.1, the valve shall be removed from the liquid bath and permitted to stabilize at ambient temperature. The valve shall then, without intervening lubrication, adjustment or repair, be fully opened; and closed with a torque of 300 ± 10 lb-in, per inch of nominal size. Damage to or improper operation of the valve as a result of this test shall be cause for rejection.

4.6.15.3 Leakage. Following the overtorque test specified in 4.6.15.2 and without intervening valve lubrication, adjustment, or repair the valve shall be fully opened, and closed with a torque of 60 ± 5 lb-in. per inch of nominal size. The valve shall then be completely immersed in clear water with the inlet subjected to a compressed air, oxygen gas, or nitrogen gas pressure of not less than 50 psig for not less than 10 minutes with the outlet open. Any leakage past the seat, through the packing, or through the valve body shall be collected and measured. Total collected gas leakage exceeding 2 cubic inches of free air, nitrogen gas, or oxygen gas per hour per inch of valve nominal size shall be considered cause for rejection.

4.6.17 Servicing and maintenance tests. All normal preventive maintenance and servicing operations specified in the maintenance and instruction handbook shall be performed to determine their adequacy, ease of accomplishment, and the accessibility of parts and assemblies for performance of same, unless such instructions are contrary to those necessary for compliance with the requirements specified herein. Insofar as practicable, these tests shall be conducted as part of the normal preventive maintenance, servicing, and inspections performed in accomplishing the testing specified herein. The servicing shall include vacuum pumping and sealing of the vacuum line. Interferences or obstructions to servicing or preventive maintenance shall be reported in detail.

4.6.18 Mobility tests. The unit shall be subjected to the general tests of MIL-M-8090 and to those specified for type II mobility items (see 6.2). In addition, compliance with the weight distribution requirements of 3.8.3.2 shall be verified. The adequacy of the stop required by 3.8.3 shall be verified by raising the tow bar of a filled tank until the center-of gravity acts to continue upward movement of the tow bar until the stop contacts dry hardened concrete. No restraining force shall be applied to limit the impact of the contact. After each test the tank shall be inspected for misalignment, distortion, and defects to determine the unit was not adversely affected by the test.

4.6.19 Environmental testing. The tank shall be subjected to the following tests conducted in accordance with the specified methods of MIL-STD-810. At the conclusion of each test, the tanks shall be examined for deterioration.

4.6.19.1 Low temperature tests.

4.6.19.1.1 Low temperature exposure test. The liquid storage tank assembly shall be filled to design capacity with liquid oxygen or liquid nitrogen and the tank subjected to low temperature in accordance with method 502.

4.6.19.1 .1.1 Pressure buildup test. Upon completion of the low temperature exposure, the unit shall be stabilized at -65°F. the inner shell vapor vent line shutoff valve shall then be closed, and the pressure buildup system actuated. The length of time required after closing of the vent valve until the vapor phase pressure has reached 50 psig shall be recorded on the test data sheets and shall not exceed 10 minutes.

4.6.19.2 High temperature test. The liquid storage tank assembly shall be filled to design capacity with liquid oxygen or liquid nitrogen and the assembly subjected to high temperature testing in accordance with method 501. The control housing access doors shall be open throughout this exposure.

4.6.19.3 Humidity test. The complete tank shall be subjected to a humidity test in accordance with method 507.

4.6.19.4 Fungus test. Equipment samples adequately representing applicable portions of the tank might be damaged by exposure to fungus attack shall be subjected to a fungus test in accordance with method 508, procedure I. -

4.6.19.5 Salt-fog test. The complete tank shall be subjected to a salt-fog test in accordance with method 509.

4.6.19.6 Rain test. The complete tank shall be subjected to a rain test in accordance with method 506.

4.6.19.7 Sand and dust test. The complete tank shall be subjected to a sand and dust test in accordance with method 510.

4.6.19.8 Wind test. It shall be demonstrated by testing or calculations that the tank will withstand the 70 mph wind specified in 3.7.7.8.

4.6.20 Servicing test. The tank shall be filled to capacity with liquid oxygen or liquid nitrogen and permitted to set with the vent valve wide open until

all uninsulated components external to the outer shell have warmed to approximately ambient temperature. The tank shall then be subjected to the testing specified in 4.6.20.1 through 4.6.20.3.

4.6.20.1 Following the filling and stabilization specified in 4.6.20, a servicing cycle shall be performed in the order listed.

- a. Connect the tank servicing hose disconnect fitting to a container suitable for use with liquid oxygen or liquid nitrogen
- b. Close the vapor vent line shutoff valve
- c. Open the liquid storage tank assembly pressure buildup control valve until the tank vapor phase pressure has risen to not less than 50 psig, after which close the buildup control valve
- d. Open the liquid servicing line shutoff valve and transfer not less than 1 gallon of liquid oxygen into the receiving container through the servicing hose
- e. Close the liquid servicing line shutoff valve
- f. Open the vapor vent line shutoff valve to vent the inner shell vapor space to atmospheric pressure
- g. Permit the tank to set with the vapor vent line shutoff valve fully open until all traces of ice and frost have disappeared from the pressure buildup coil, valves, and servicing line. The application of external heat to expedite warmup is permissible.

4.6.20.2 The servicing cycle specified in 4.6.20.1 shall be repeated until the storage tank has been subjected to not less than fifty such cycles.

4.6.20.3 The tank shall complete not less than fifty servicing cycles without necessity for servicing or maintenance of any kind, or shall be considered to have failed the test.

4.6.21 Mechanical check. Upon completion of the above tests, a critical inspection shall be made of components to determine their operability and any damage or undue wear incurred during the tests. Teardown and parts measurement shall be made only in those cases where service life is in question. Where teardown and parts measurements are performed, wear or distortion that exceeds limits permitted by the manufacturer for new parts shall be cause for considering the part or parts affected as having failed to complete the test satisfactorily.

4.6.21.1 Steel parts subject to high stress in operation and that are suspected of having defects shall also be subjected to magnetic particle inspection and shall exhibit no indications of damage attributable to the tests, or shall be considered as having failed the test. Grinding checks and subsurface indications of laps or seams shall not be cause for rejection. Magnetic particle inspection shall be performed in accordance with MIL-I-6868.

4.6.21.2 Nonmagnetic parts suspected of defects shall be subjected to inspection with fluorescent penetrant (black light) and shall exhibit no breaks or other defects that would impair their life or usefulness. Penetrant inspection shall be performed in accordance with MIL-I-6866.

4.6.22 Reliability demonstration. Satisfactory completion of all tests specified herein with no failure preventing satisfactory performance shall be considered as demonstrating compliance with the quantitative reliability requirement. Any test resulting in a failure shall be documented. Apparent failures that are caused by some unintended factor external to the equipment (for example, test equipment failure) need not be counted as reliability failures if the cause can be substantiated to procuring activity satisfaction. Acceptance for reliability put-poses shall not be made until, to the satisfaction of the procuring activity, each failure has been analyzed, the cause determined, design or other modifications made to preclude repetition of the failure or related failures, successful retest made by the contractor of the failed equipment with the modifications included, and contractor action taken to reflect the modifications in equipments to be delivered. In addition to a particular failed test, any retest shall include all tests that could be influenced by the modifications.

4.6.23 Maintainability demonstration. Compliance with maintainability requirements shall be demonstrated by task performances as specified below. The active maintenance downtimes, the tools and equipment required, and any obstructions or conditions hindering the task or presenting potential hazards to personnel or to parts shall be observed and recorded. Signs of excessive wear or other indications of potential failure shall be recorded where observed and the information supplied to the design activity for study and for recommendation of any appropriate corrections to be reflected in future items delivered. Such recommendations shall be subject to procuring activity approval before being implemented, or successful repeat of other test specified herein may be required where the test result could be influenced by the correction. It shall be demonstrated that the item is in satisfactory operating condition after the maintenance tasks have been done. Maintenance task time data from maintenance and teardown inspection made in connection with other specified demonstrations may be applied to the maintainability demonstration if adequate observations are made and recorded.

4.6.23.1 Corrective maintenance. Compliance with quantitative corrective maintenance downtime requirements shall be demonstrated by a maintenance demonstration procedures maintenance task selection, and maintenance task performances in accordance with MIL-STD-471 including appendix A and appendix B, method 1, test plan pair (A1 plus B1).

4.6.23.2 Preventive maintenance. Compliance with the quantitative preventive maintenance downtime requirements shall be demonstrated in accordance with MIL-STD-471, appendix B, method 6. Each task need not be done more than once. For maximum preventive maintenance downtime demonstration, less than 0.1 (10 percent) of the task times observed shall require greater downtime than the quantitative requirement.

4.7 Inspection of preparation for delivery. Preservation, packaging, packing, and marking shall be inspected determine compliance with the requirements of section 5 or the documents specified herein.

5. PREPARATION FOR DELIVERY

5.1 General instructions

5.1.1 Cleaning. The tank shall be thoroughly cleaned to removed excess and spilled lubrication materials, loose or chipped paint, spilled chemicals, and other foreign materials. All cleaning solvents shall be thoroughly removed from the tank components and accessories prior to delivery.

5.1.2 Repainting. Tank surfaces on which the paint is damaged or defective shall be thoroughly cleaned and repainted as specified under 3.12.

5.1.3 Liquid storage tank assembly purging and sealing, The liquid storage tank assembly inner shell shall be drained of all liquids and purged with not less than 100 standard (68°F and 760 mm Hg) cubic feet of clean, dry oil-free nitrogen gas introduced through the vapor phase vent line specified in 3.8.1.7. 1.3. The liquid fill-drain and servicing line shutoff valves shall be opened individually and the flow permitted to purge the respective lines, valves, and fittings. The bulk of the purge gas shall be exhausted through the liquid fill-drain line specified in 3.8,1.9.4.2.

5.1.3.1 Following the purging, the inner shell shall be pressurized to not less than 10 psig nor more than 20 psig with clean, dry, oil-free nitrogen gas, after which every valve and line leading into the inner shell shall be closed. The ends of all pipes, tubes, and couplings shall be securely sealed with pressure-sensitive tape conforming to PPP-T-60.

5.1.3.2 A type A tag conforming to UU-T-81, with tag and printing waterproofed, stating that the liquid storage tank assembly inner shell is cleaned and pressurized with clean, dry, oil-free nitrogen gas and indicating the date and the pressure to which the annular insulation space has been evacuated, shall be securely attached to the vapor vent line shutoff valve handle in a conspicuous location.

5.1.4 Preservatives. Preservatives and lubricants shall bot be applied to any part of the equipment that will come into contact with high-purity-oxygen. "

5.2 Packaging (see 6.2).

5.3.1 Level A. The tank, preserved and packaged as specified in 5.2.1, shall be packed in exterior-type shipping containers conforming to MIL-C-104, and appendix thereto (type H, class 2, style a).

5.3.2 Level B. The tank, preserved and packaged as specified in 5.2.1 and being shipped in less than full carload or full truckload lots, shall be packed as

specified in 5.3.1. When shipped in full carload or full truckload lots, the tank shall be provided with a wooden shield constructed to provide protection for the Instruments and controls while the tank is in transit or storage. The shield shall enclose the entire instrument and control area and shall be securely fastened to the tank. Exterior shipping containers will not be required.

5.3.3 Level C. Tanks that require overpacking for acceptance by the carrier shall be packed in exterior-type shipping containers in a manner that will insure safe transportation, at the lowest rate, to the point of delivery. Containers shall meet Consolidated Freight Classification Rules or regulations of other common carriers as applicable to the mode of transportation.

5.4 Physical protection. Cushioning, blocking, bracing, and bolting as required shall be in accordance with MIL-STD-1186, except that for domestic shipments, waterproofing requirements for cushioning materials and containers shall be waived when preservation, packaging, and packing of the item are for immediate use or when the drop tests of MIL-P-116 are applicable.

5.5 Shipment marking. Tanks shall be marked for shipment in accordance with MIL-STD-129. The nomenclature shall be as follows:

TANK, MOBILE STORAGE, LIQUID OXYGEN
50 GALLON CAPACITY,
TMU-27/M

6. NOTES

6.1 Intended use. The TMU-27/M tank is intended for use in servicing aircraft liquid breathing oxygen systems and any other application where aviator's liquid breathing oxygen is used. The unit can be airlifted when filled to capacity and placed in use immediately upon arrival.

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number, and date of this specification
- b. That MIL-M-8090 be used in conjunction with this specification (see 3.5.1)

When a complete set of all special tools, other than common handtools and those normally available in motor vehicle repair shops, is to be provided (see 3.6.12)

- d. Registration number required (see 3.13.5)
- e. Location and conditions for preproduction testing (see 4.4)
- f. That, when specified, the preproduction tests may-be waived if the contractor's item has previously passed the preproduction tests specified herein
- g. Required level of preservation, packaging, and packing (see section 5)

6.3 Definitions. For the purpose of this specification, the following definitions will apply:

6.3.1 Failure. For reliability purposes, a failure is defined as any failure or malfunction that could prevent satisfactory (within specified limits) and safe operation in the primary functions of receiving, storing, transporting, and dispensing the specified liquid.

6.3.2 Fibrous particle. A fibrous particle is defined as a long, slender particle whose maximum cross-sectional dimension is 40 microns.

6.3.3. Ambient conditions. Ambient conditions are the dry-bulb temperature, wet-bulb temperature, and the relative humidity of the atmospheric air surrounding and in the vicinity of the tank, but unaffected by any heat or cold" emanating from the tank itself.

6.3.4 Valve cycle of operation. A cycle of operation for a valve is defined as opening the valve from sealing a differential pressure of not less than 50 psig to the not less than three-fourths open position, and reclosing the valve with a torque of 60 ± 5 lb in. per inch of valve nominal size.

6.3.5 Pressures. All pressures referred to herein, unless specified as absolute or denoted by the symbol psia, will be interpreted as pounds per square inch (psi) gage.

6.4 International interest. Certain provisions of paragraphs 3.7.4.3.8.1.3.3, and 3.8.1.7.1.2 of this specification are the subject of international standardization agreement Air Standardization Co-ordinating Committee Air Standard 14/3, STANAG 3547. When amendment, revision, or cancellation of this specification is proposed which will effect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, Including departmental standardization offices, if required.

6.5 Recycled, virgin and reclaimed materials. Provided that all other requirements of this specification are met, reclaimed materials shall be used to the maximum extent possible with no exclusion to the use of recovered materials and no requirement that an item be manufactured from virgin materials.

6.6 NOTE. This specification contains major revisions throughout so no asterisks have been used to denote changed paragraphs.

Custodian:

Air Force -68

Review Activity:

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Project No. 3655-F090

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DOCUMENT IDENTIFIER (Number) AND TITLE

MIL-T-38170F (USAF) TANK, MOBILE STORAGE, LIQUID OXYGEN TMU-27/M

NAME OF ORGANIZATION AND ADDRESS OF SUBMITTER

☐ VENDOR ☐ USER ☐ MANUFACTURER

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